24th ANNUAL CONGRESS

20-23 September, 2011

International Society for Technology in Arthroplasty 2011

Theme:
Bridging the gap between innovation and evidence-based practice in Arthroplasty

Location:
Concert Building, Bruges (Brugge), Belgium, Europe

Important deadlines:

Submission of abstracts: **May 15th, 2011**
Submission of full papers for the awards: **May 15th, 2011**
Notification of acceptance of the abstract for the program: **June 15th, 2011**
Discounted early registration: **July 15th, 2011**

www.istaonline.org

Invitation

Dear Colleagues,

It is with pleasure that we are inviting you to the 24th annual congress of the International Society for Technology in Arthroplasty, which is to be held in Brugge, Belgium at 21-23 September, 2011. ISTA'11 is a meeting for orthopaedic surgeons, scientists, engineers, allied health and representatives from orthopaedic industry. The goal of the meeting is to promote transfer of knowledge in the field of arthroplasty in the broadest thinkable sense.

The theme of this years' meeting is 'Bridging the gap between innovation and evidence based practice in arthroplasty', which demonstrates our initiative to address the incompatibilities that are often present between innovation of orthopaedic implants on the one hand and evidence based practice on the other. Renowned speakers are invited to address this issue from their perspective. Furthermore, key-experts will inform you about the most recent developments related to technology and clinical performance in arthroplasty. and we will organize at least two dedicated sessions on Computer Assisted Orthopaedic Surgery in conjunction with the International Society of CAOS. Further scientific high-lights of the meeting are the presentation of the ISTA's Life Time Achievement Award, the HAP Paul award and the Biomechanics and Biomaterials Student awards.

The venue is situated in the heart of the beautiful city of Brugge, which is included in the UNESCO list of the World Heritage. The city radiates beauty, history and romance and we guarantee that your presence will be a memorable experience.

The organizing committee is putting together an exciting scientific as well as a social program and we look forward to receive your submissions for the award papers, your abstracts for the open program, and, most of all, look forward to welcome you personally in Brugge!

Nico Verdonschot PhD
Johan Bellemans PhD MD
Jan Victor PhD MD
Meeting Co-Directors

Scientific program

1. HIP AND KNEE ARTHROPLASTY

- Knee Mechanics
- Hip Mechanics
- Alternative Bearing Materials in THA
- Ethnic and Gender Issues in Arthroplasty
- Patellar Resurfacing Issue
- Bearing Mobility Issues
- Hip Resurfacing
- High Demand Issues

2. ENABLING TECHNOLOGIES

- Computer Navigation in Joint Replacement
- Minimally Invasive Surgical Techniques
- Sensor Technology in Arthroplasty
- Computer simulations
- Musculo-skeletal modeling
- Imaging Technology
- Robotics
- Evidence Based Medicine
- Functional analyses

3. NON ARTHROPLASTY PROCEDURES/ISSUES

- Peri-prosthetic Fracture Management
- Cartilage Repair/Regeneration
- Complication Management
- Hip Disease: Non Arthroplasty Options
- Knee Disease: Non Arthroplasty Options

4. SPINE, SHOULDER AND SMALL JOINT ARTHROPLASTY

- Spinal Fusion vs. Disc Replacement
- Shoulder Complications and Arthroplasty Options
- Ankle Complications and Arthroplasty Options

Congress program

Tuesday, Sept. 20, 2011
18.30: Welcome reception City Hall, Bruges

Wednesday, Sept. 21, 2011
08.30 - 17.00: Scientific Session
18.00 - 20.00: Posters Session

Thursday, Sept. 22, 2011
08.30 - 16.00: Scientific Session
16.00 - 17.00: Award Session
19.30: Award dinner at Provinciaal Hof, Bruges

Friday, Sept. 23, 2011
08.00 - 16.00: Scientific Session

ISTA Life Time Achievement Award

Professor Tony Unsworth *started his career in 1969 at Leeds University and works at Durham University since 1976 where he is Director of the Centre for Biomedical Engineering and Research Director for the Faculty of Science. His research area is the tribology of human and artificial joints but in addition he has published on aspects of rehabilitation of the upper limb. He has been awarded the Tribology Silver Medal in 1972, the Donald Julius Groen Prize, the James Clayton Prize,1999 (IMechE) and in 2005 was awarded the James Alfred Ewing Medal of the Institution of Civil Engineers for his research into the Tribology of human and artificial human joints. He has published in excess of 310 papers and given circa 100 lectures at international conferences/ venues.*

www.istaonline.org

Invited Speakers (to be adjusted)

Lars Engebretsen, **Norway**
Rick Komistek, **USA**
Dan Berry, **USA**
Jerry Engh, **USA**
Jean-Noel Argenson, **France**
Philippe Neyret, **France**

David Murray, **UK**
Andrew Amis, **UK**
?? Lombardi, **USA/Italy** (??)
Fabio Catani, **Italy**
Philipp Lobenhoffer, **Germany**
Roland Becker, **Germany**

Christian Gerber, **Switzerland**
Ate Wymenga, **Netherlands**
Wim Schreurs, **Netherlands**
Jean-Piere Simon, **Belgium**
Rene Verdonk, **Belgium**
Arun Mullaji, **India**

Award Paper Criteria

1. LIFETIME ACHIEVEMENT AWARD

This award recognizes a life long contribution to advancing the state of the art in joint reconstruction that has changed the landscape of arthroplasty. This achievement was acknowledged in the past years to Drs. Burstein, Goodfellows, Ranawat, Freeman, Yamamuro and Walker. The recipient at ISTA 2010 will give a 20-minute presentation in a plenary session and the award will be presented during a special ceremony at the Gala Dinner.
The plaque is sponsored by ISTA.

2. "HAP" PAUL AWARD

($3,000 US CASH AWARD)

Howard A. Paul, DVM, was a tireless researcher advancing the science and technology of arthroplasty. He was one of the charter members of ISTA and an award has been established to honor his outstanding contribution. A special 20-minute presentation will be presented in a plenary session for the best paper on new developments in the field of arthroplasty and the award will be presented during a special ceremony at the Gala Dinner.

3. STUDENT BIOMECHANICS PAPER AWARD

($1,000 US CASH AWARD)

This award will be presented to a student who submits the best paper on biomechanics in the field of arthroplasty. The recipient will give a 10-minute presentation at a plenary session. The award will be presented at the Gala Dinner.

4. STUDENT BIOMATERIALS PAPER AWARD

($1,000 US CASH AWARD)

This award will be presented to a student who submits the best paper on biomaterials in the field of arthroplasty. The recipient will give a 10-minute presentation in a plenary session. The award will be presented at the Gala Dinner.

5. POSTER AWARDS

($1,000 US CASH AWARD)

Three poster awards will be awarded – $500, $250 and $250 – to the top three posters presented at the meeting.
Posters will be judged at the meeting.
The awards will be presented at the Gala Dinner.

APPLICATION FOR AWARDS 2-4

For the awards No. 2-4, researchers can apply by submitting both an abstract and a full paper. Authors can submit as many papers as they want for different awards, but only one paper will be accepted for each presenting author. For students participating for the awards, a written confirmation of the student-status of the first author should be provided by the supervisor of the applicant. Applicants are asked to indicate which award they are applying for in the last section of the abstract submission form.
Please prepare the full paper following the guidelines for the Journal of Arthroplasty (see http://www.arthroplastyjournal.org/authorinfo) and submit the paper through the on-line process located on ISTA's website: **www.ISTAonline.org**

The awards winning papers will be forwarded to the Journal of Arthroplasty for publication; however, there is no guarantee that the papers will be accepted for publication.

ABSTRACT SUBMISSION

Abstract and Award Papers must be submitted via the ISTA 2011 official website at **www.ISTAonline.org**. Submissions will open on March 1, 2011 and close on May 15th, 2011. Abstract notifications will be sent on June 15th, 2011. Abstract and Award Papers will only be considered if they are submitted through the ISTA on-line submission process. For any inquiries, please feel free to contact the congress secretariat using the information provided on **www.ISTAonline.org**.

Registration

REGISTRATION FEES FOR THE ISTA 2011 ARE LISTED BELOW.

THE PROFESSIONAL REGISTRATION FEE INCLUDES

- Final Program and Abstract book (with CD)
- Access to the research electronically
- Reception, lunches and coffee breaks
- Admission to all oral scientific lectures
- Admission to the poster session
- Admission to the exhibit hall

CME ACCREDITATION

The 24th Annual Congress of the International Society for Technology in Arthroplasty is planned and organized in accordance with the policies of the European Accreditation Council for Continuing Medical Education (EACCME). The EACCME is an institution of the European Union of Medical Specialists (UEMS), www.uems.be. EACCME approved credits are recognized by the American Medical Association for conversion to AMA PRA Category 1 Credit™.

CATEGORY	UNTIL JULY 15, 2011	JULY 16 – AUGUST 15, 2011	FROM AUGUST 16, 2011
Professional	€ 450	€ 500	€ 550
ISTA member	€ 400	€ 450	€ 500
Fellow/Resident/ Allied Health	€ 200	€ 250	€ 275
Graduate Student	€ 200	€ 250	€ 300

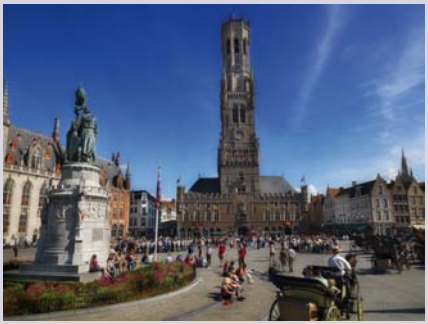
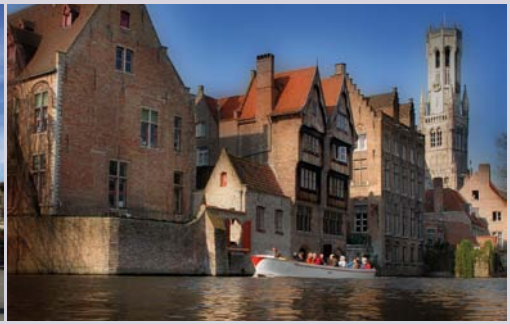
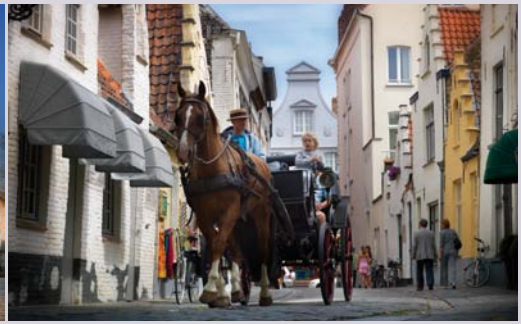
Accommodation

Due to the specific historical charm of the city of Bruges (Brugge), we made a selection of different hotels close (walking distance) to the congress location (Concert Hall). Please consult the website (www.istaonline.org) to find the different hotel possibilities with the ISTA negotiated rates (reduced rates). You will also find the contact/booking details of each hotel for direct booking of your accommodation.

Airport Transfer

A pre-bookable transfer service from Brussels Airport (Zaventem) to Bruges will be provided at an interesting rate. Information will be communicated to all registered participants in due time.

Bruges, one of the most beautiful cities in Europe…

It was a justified motive that prompted UNESCO in 2000 to include the entire historical city centre on the World Heritage list. Walking along the maze of winding cobbled alleys and romantic canals, you imagine yourself to be in medieval times. The wealth of museums is a striking image of this city's stirring history.

Bruges is also home to contemporary culture, such as the new Concert Hall, which is one of the most prominent music complexes in Flanders.

The restaurants in Bruges which offer gastronomic cuisine and the exclusive hotels are a true feast for those who enjoy the good things in life.

Join us to explore this medieval beauty…

ISTA supported social events:

Reception Tuesday, September 20, 2011 | City Hall, Bruges.
Award dinner Thursday, September 22, 2011 | The Provincial Court, Bruges.
Participation fee € XX per person | On-line pre-booking only.

Social Partner Program:

Wednesday September 21, 2011 – 18h30 (06.30 pm)
(pre-registration possible through congress registration on-line)

Bruges' highlight Tour (2 hours) - Price: pp 45 €

This tour will encompass all the high spots that Bruges has to offer. The historic center is part of the UNESCO World Heritage since the year 2000.
With his loud voice and a bell the Belleman of Bruges announces the tour in front of the Concert Hall. With our enthusiastic guides you will pass by the well-known Beguinage, the majestic Palace of Gruuthuse, Our Lady's Church, the ancient Burg square and its gothic City Hall, the Basilica of the Holy Blood and the impressive market square with the famous Bell Tower.
During the tour we invite you to the secluded inner garden of the Bladelin Court, the medieval house of the family de Medici, which houses a convent nowadays. Here a musical duo plays a concert on their self made medieval instruments and we offer you a little box of tasty chocolates made in Bruges.
At the fish market fish sellers will welcome you in their fish selling scène. They offer you a tasty fish bite and a real Belgian jenever.
During the tour a private boat trip on the Bruges' canals is also included!

Social program possibilities:

(bookable on site, upon availability, at the Concert Hall special desk)

Flanders Fields - Day Tour (8hrs) - Price: pp 85 €

A full day tour with private coach or mini-van to Flanders Fields.
Pick-up at the Concert Hall on 't Zand. Day tour includes:

- *The largest WW1 German cemetery (Student cemetery) in Langemark.*
- *The world's largest WW1 cemetery of the Commonwealth: Tyne cot Cemetery at Passchendale.*
- *The Menin gate at Ypers, hill 60, hill 62, bunkers during the day.*
- *Visiting the centre of Ypres and we will have a lunch in Ypres.*
- *Mount Kemmel cote 160, the Hills of Flanders.*
- *Different WW1 trenches and also memorials from the Commonwealth.*

Brussels - Day Tour (8hrs) - Price: pp 115 €

A full day tour with private coach or mini-van to Brussels.
Pick-up at the Concert Hall on 't Zand.
Brussels, the capital of Belgium and Europe is a meeting point of diverse architectural, literary, historical and cultural currents, set right in the heart of Belgium. During this tour, you will discover the city of Brussels with the help of our professional guides, who will describe its historyand social life. Driven by coach you will discover Laeken, the residential and royal commune with its historical castles, which forms the private residence of the Royal Family of Belgium. In this area you will also see the site of the World Exhibition, the Trade Mart, the Planetarium and Brupark – Mini Europe, all dominated by the impressive Atomium.
During the drive through the European district, at the edge of the Cinquantenaire Park and its monumental ensemble, built under Leopold II, your guide will outline the European functions of Brussels. Via the Royal District with its Palace and Park, the Parliament buildings and the Congress Column, we will descend gently to the lower town and its famous Grand Place.
During the second part of this excursion, you will discover by foot (pedestrian zone) the Town Hall (Hôtel de Ville) surrounded by Guild Houses, Brussels most famous citizen Manneken Pis and finally the winding little streets of the Ilôt Sacré.
Incl lunch in Brussels.

Bruges Art Route (3 hrs) - Price: pp 52 €

An arty tour where we get an exclusive insight in the lives and work of 4 local artists. We get a look behind the scenes and a demonstration of their art. For example an airbrush artist, a young letter-cutter in stone, a glass blower etc. Drinks and little bites are provided during the visits.

Bruges in 5 Senses (3 hrs) - Price: pp 75 €

A sensory walk in 5 steps along Bruges' hidden spots. We listen to the sounds of a small concert and taste and smell chocolate at the workshop of a top chocolatier. In the working place of Peter Quijo we see how a rough gem is polished to a brilliant diamond. And we finish with a hand massage. And maybe we can even tempt your sixth sense!

Bruges - Damme by Bike (3,5 hrs) - Price: pp 36 €

Just outside Bruges is a unique natural area that extends to the coast (North Sea). Jacques Brel called this polders "Le Plat Pays". Central in this Polders we find some small mediaeval towns like Damme, Oostkerke and Hoeke. Little white villages with a medieval past as a link between Bruges and the sea. Together with our guides we cycle through the beautiful nature and obviously we do not forget to taste our local specialties such as beer and waffles.

Tranquil Bruges (3 hrs) - Price: pp 45 €

A private boat awaits us in the historic city center and takes us to the heart of Saint-Anne, a quiet beautiful part of Bruges that's unknown to tourists. Here we find the part of Bruges with its cobblestone streets, alms houses, windmills, churches and unique views of the canals. During this walk we visit the well conserved Lace Center and see a demonstration of this traditional Bruges' handicraft. And of course we also have a drink in the oldest pub in town, Café Vlissinghe that dates from 1515.

Golf activities on request.

Organizing committee

Local Organizers:

Nico Verdonschot
Johan Bellemans
Jan Victor
Dennis Janssen
Wim Schreurs
Pieter Spierings

ISTA Board members:

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Richard D. Komistek	*First Past President*
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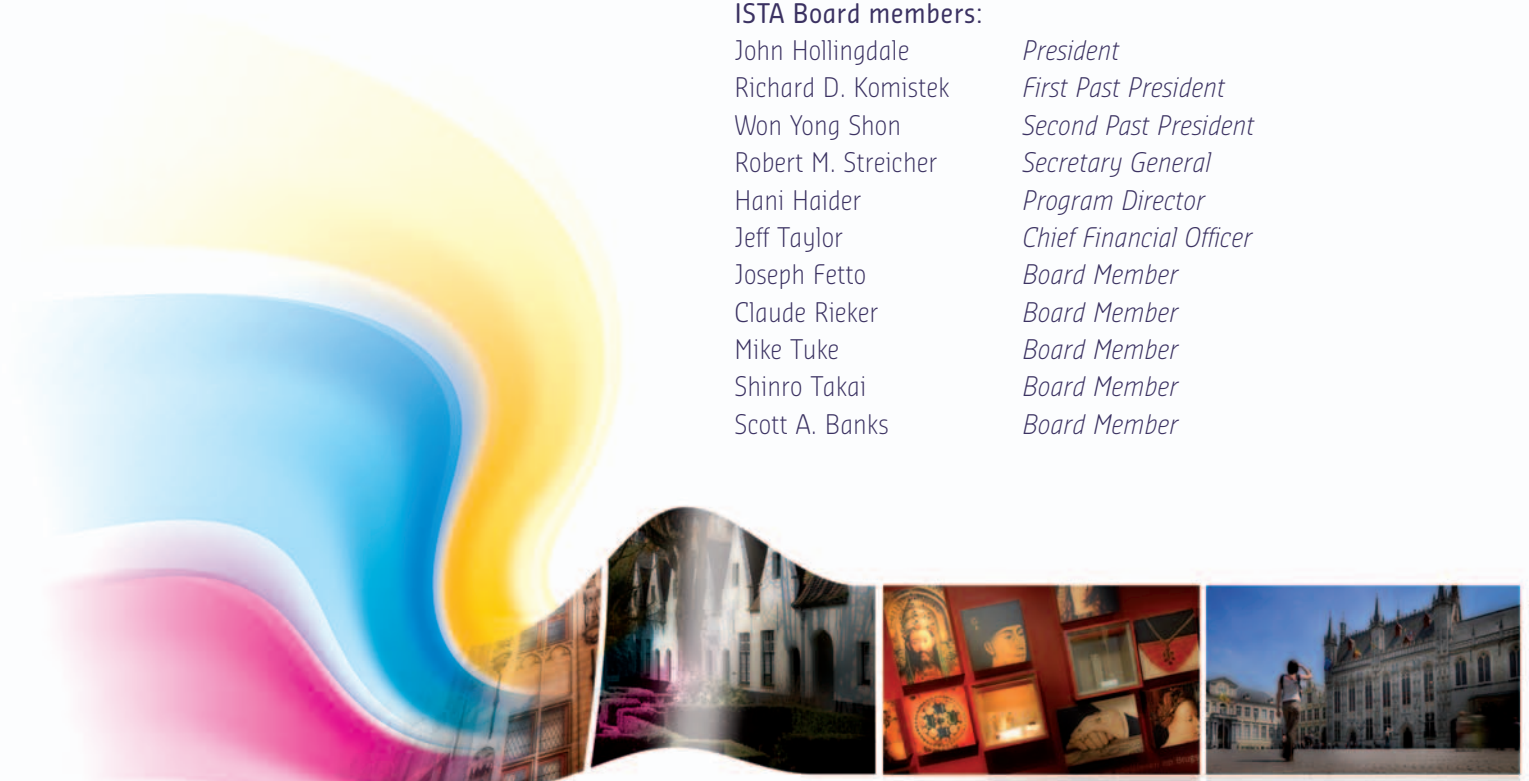

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ISTA 2011

September 20-23, 2011
Concert Hall Bruges, Bruges, Belgium

Congress Chair:
John Hollingdale, M.

Wear of Ceramic-on-Ceramic Bearings in THRs: Effect of Head Size Under Steep Cup Inclination Angle and Microseparation and Edge Loading Conditions

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INTRODUCTION

Ceramic-on-ceramic hip replacements have generated great interest in recent years due to substantial improvements in manufacturing techniques and material properties[1]. Microseparation conditions that could occur due to several clinical factors such as head offset deficiency, medialised cup combined with laxity of soft tissue resulting in a translation malalignment, have been shown to cause edge loading, replicate clinically relevant wear mechanisms[2,3] and increase the wear of ceramic-on-ceramic bearings[3,4]. The aim of this study was to investigate the influence of increasing the femoral head size on the wear of ceramic-on-ceramic bearings under several clinically relevant simulator conditions.

MATERIALS AND METHODS

The wear of size 28mm and 36mm ceramic-on-ceramic bearings (BIOLOX® *Delta*, CeramTec, Germany) was determined under different *in vitro* conditions using the Leeds II hip simulator. For each size bearing, two clinical cup inclination angles were considered, 55^{o} (n=3) and 65^{o} (n=3) for the 28mm bearing and 45^{o} (n=3) and 65^{o} (n=3) for the 36mm bearing. The first two (28mm study) or three (36mm study) million cycles ran under standard gait conditions and a subsequent three million cycles ran under microseparation conditions. A standard gait cycle included a twin peak load (300N-3000N), extension/flexion ($-15^{o}/+30^{o}$) and internal/external rotation ($\pm 10^{o}$). Microseparation[3] was achieved by applying a 0.4-0.5mm medial displacement to the cup relative to the head during the swing phase of the standard gait cycle resulting in edge loading at heel strike. The lubricant was 25% (v/v) newborn calf serum, which was changed approximately every 333,000 cycles. The wear volume was ascertained through gravimetric analysis every million cycles. One-way ANOVA was performed (significance: $p<0.05$), and 95% confidence limits were calculated.

RESULTS AND DISCUSSION

The mean wear rate under standard gait conditions was $0.05mm^3$/ million cycles for the 28mm bearings and significantly lower ($p=0.003$) for the 36mm bearings (Figure 1) which could be due to improved lubrication regime. The wear of ceramic-on-ceramic bearings was not influenced by the increase in cup inclination angle for either bearing size (Figure 1). The introduction of microseparation into the gait cycle resulted in stripe wear on the femoral head with a corresponding wear area at the rim of the acetabular cup and significantly higher wear rates of the ceramic-on-ceramic bearings (Figure 2). The wear rate of BIOLOX® *Delta* bearings under microseparation conditions was still low ($<0.25mm^3$/million cycles) compared to the third generation alumina ceramic-on-ceramic bearings ($1.84mm^3$/million cycles)[4] under the same adverse conditions. Under microseparation conditions, the wear rate of size 36mm bearings was significantly higher ($p=0.004$) than that for size 28mm bearings. This was thought to be due to the larger contact area for the larger bearings and deprived lubrication under edge loading conditions. For both bearing sizes, the combination of both steep cup inclination angles and microseparation conditions did not increase the wear rates any further compared to microseparation conditions alone (Figure 3).

This study shows the importance of surgical positioning of the femoral head and acetabular cup and the importance of testing new bearing materials and designs using these adverse simulator methods.

ACKNOWLEDGEMENT

This study was supported by the Furlong Research Charitable Foundation (FRCF) and the National Institute of Health Research (NIHR) as part of a collaboration with the Leeds Musculoskeletal Biomedical Research Unit

(LMBRU).

REFERENCES

Masson, International Orthopaedics,2009;33:359-363.

Nevelos *etal*.,Biomaterials,1999;20(19):1833-40.

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Figures

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Figure 6

8B : Bearings - hip: #822 September 22nd, 2011, 13:55-14:45

Wear of Metal-on-Metal Bearings in THRs: Effect of Head Size Under Steep Cup Inclination Angle, Microseparation and Edge Loading Conditions

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INTRODUCTION

Retrieval and clinical studies of metal-on-metal (MoM) bearings have associated increased wear[1] and elevated patient ion levels[2] with steep cup inclination angles and edge loading conditions. The University of Leeds have previously developed a hip simulator method that has been validated against retrievals and shown to replicate clinically relevant wear rates and wear mechanisms[3,4]. This method involves introducing lateral microseparation to represent adverse joint laxity and offset deficiency. This study aimed to investigate the effect of microseparation representing translational malpostion, and increased cup inclination angle, representing rotational malposition, in isolation and combined on the wear of different sizes (28 and 36mm) MoM bearing in total hip replacement (THRs).

MATERIALS AND METHODS

The wear of size 28mm and 36mm MoM THRs bearings was determined under different *in vitro* conditions using the Leeds II hip simulator. For each size bearing, two clinical cup inclination angles were considered, 45^{o} (n=3) and 65^{o} (n=3). The first three million cycles were run under standard gait conditions and subsequently three million cycles were run under microseparation conditions. Standard gait cycles included a twin peak load (300N-3000N), extension/flexion ($-15^{o}/+30^{o}$) and internal/external rotation ($\pm10^{o}$). Microseparation[4] was achieved by applying a 0.4-0.5mm medial displacement to the cup relative to the head during the swing phase of the standard gait cycle resulting in edge loading at heel strike. The lubricant was 25% (v/v) newborn calf serum. The wear volume was determined through gravimetric analysis every million cycles. One-way ANOVA was performed (significance: $p<0.05$), and 95% confidence limits were calculated.

RESULTS

Under standard gait conditions, the 28mm MoM bearing showed head-rim contact and increased wear rate with increased cup inclination angle but the 36mm bearing did not show any increase in wear. Microseparation and edge loading increased the wear rate of MoM bearings for all cup inclination angle conditions and bearing sizes

(Figure 1).

DISCUSSION

With the larger size bearings, head-rim contact occurred at a steeper cup inclination angle (>65^{o}) providing an advantage over smaller bearings. Under standard gait conditions, where head-rim contact did not occur, wear was low, due to mixed lubrication and wear reduction through a protein boundary film. However, edge loading of the cup, with elevated stress, caused excess damage and wear. This effect was more dominant with microseparation conditions to that of head-rim contact due to increased cup inclination angle alone.

Under microseparation conditions, there were no significant differences in the wear rates of the 28mm and the 36mm size bearings. However, the wear rates obtained in this study for 28mm and 36mm bearings were significantly lower than those obtained for size 39mm surface replacement MoM bearings (8.99 mm^{3}/million cycles) tested under the same adverse conditions[5].

CONCLUSION

This study shows the importance of acetabular cup design and correct surgical positioning of the femoral head and acetabular cup and restoration of offset and cup centre.

ACKNOWLEDGEMENT

This study was supported by the Furlong Research Charitable Foundation (FRCF) and the National Institute of Health Research (NIHR) as part of a collaboration with the Leeds Musculoskeletal Biomedical Research Unit (LMBRU). The components were custom made specifically for this project by Corin Ltd.

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De Haan *et al*.,JBJS Br, 2008.**90**(10):p.1291-7.

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Figures

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Figure 2

5B : Spine: #857 September 21st, 2011, 16:20-17:10

The Effect of Varying the Stiffness of Spinal Fusion Devices on the Adjacent Levels Using Multibody Dynamics Simulation

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Sebastian Dendorfer - University of Applied Sciences Regensburg - Regensburg, Germany
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INTRODUCTION:

Several clinical studies demonstrated long-term adjacent-level effects after implantation of spinal fusion devices[1]. These effects have been reported as adjacent joint degeneration and the development of new symptoms correlating with adjacent segment degeneration[2] and the trend has therefore gone to motion preservation devices; however, these effects have not been understood very well and have not been investigated thoroughly[3].

The aim of this study is to investigate the effect of varying the stiffness of spinal fusion devices on the adjacent vertebral levels. Disc forces, moments and facet joint forces were analyzed.

METHODS:

The AnyBody Modeling System was used to compute the in-vivo muscle and joint reaction forces of a musculoskeletal model. The full body model used in this study consists of 188 muscle fascicles in the lumbar spine and more than 1000 individual muscle branches in total. The model has been proposed by de Zee et al. [3],validated by Rasmussen et al.[4] and by Galibarov et al.[5]. The new model[5] determines the individual motions between vertebrae based on the equilibrium between forces acting on the vertebrae from muscles and joints and the passive stiffness in disks and ligaments, figure1a. An adult of 1.75 m and 75 kg with a spinal implant in L4L5 was modeled. This model was subjected to a flexion-extension motion using different elastic moduli to analyze and compare to a non-implanted scenario. The analyzed variables were vertebral motion, the disc reaction forces and moments, as well as facet joint forces in the treated and the adjacent levels: L2L3, L3L4, L4L5 and L5-Sacrum.

RESULTS:

When introducing a spinal fusion device in the L4L5 joint the reaction forces and moments decreased in this joint with stiffer devices leading to lower joint loads. However, in the adjacent joints, L3L4 and L5Sacrum, an increase was observed when implanting stiffer devices. Similar trends could be found for the L2L3 joint. The loads in the facet joints showed the same trends. While introducing a spinal fusion device reduced the facet joint forces in the treated joint, the loads in the adjacent facet joints were increased according to the stiffness of the implanted device, figure1b.

DISCUSSION:

While the treated disc joint showed reduced motion and loads, the adjacent levels demonstrated a significant increase. In particular, the increased facet joint forces in the adjacent levels can lead to adjacent level facet pain or accelerated facet joint degeneration. Introducing a device resulted in preventing facet contact and therefore facet joint loads, even using the device with the lowest stiffness.

CONCLUSION:

The presented model shows that clinical complications such as facet joint degeneration in adjacent levels after implantation of spinal fusion device are consistent with the change in the mechanical-stimulus distribution in the system.

REFERENCES:

[1] Panjabi, M., Clinical Biomechanics 22(3): 257-265.

[2] Hilbrand and Robbins, M., The Spine Journal 4(6):190-194.

[3] de Zee, M. et al., J Biomech 40(6): 1219-1227.

[4] Rasmussen, J. et al., XXII ISB Congress, Cape Town, 2009.

[5] Galibarov, P. et al., ORS Annual Meeting, Long Beach, 2011.

Figures

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Figure 2

An Alternative Unloading Implant for Medial Knee Oa in the Young and Active Patient

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Introduction

Osteoarthritis (OA) represents a leading cause of disability and a growing burden on healthcare budgets. OA is particularly vexing for young, active patients who have failed less invasive therapies but are not ideal candidates for HTO or arthroplasty. Often, patients suffering in this wide therapeutic gap face a debilitating spiral of disease progression, increasing pain, and decreasing activity until they become suitable arthroplasty patients. An

implantable unloading device was evaluated for the treatment of medial knee OA in this patient population.

Joint overload has been cited as a contributor to OA onset or progression. In response, the KineSpring® System (Moximed, Inc, USA) has been designed to reduce the load acting on the knee. The unloader is implanted in the subcutaneous tissue without violating the joint capsule, thus preserving the option of future primary arthroplasty. The implant may be particularly useful for young, active patients, given the reversibility of the procedure and the preservation of normal flexibility and range of motion.

Methods and Results

The KineSpring System was implanted in 79 patients with isolated medial knee OA, and the longest duration exceeds two and a half years. Treated patients were young and obese (mean age: 52 years, range 32 – 75; mean BMI: > 30 kg/m^2, range 21 - 45). Acute implant success, adverse events, and clinical outcomes using validated patient reported outcomes tools were recorded at baseline, post-op, 2 and 6 weeks, and 3, 6, 12 and 24 months post-op. All centers received ethics committee approvals prior to enrolling patients in the study.

Mean surgical time was 72 min (range 45 – 153 minutes), and all patients were discharged after a few days. Patients recovered rapidly, achieving full weight bearing within 1 - 2 wks and normal range of motion by 6 weeks. Most patients experienced significant pain relief and functional improvement by six weeks, with results sustained beyond the two-year follow-up visit. WOMAC Pain improved from 43 at baseline to 13 at 2 years ($p<0.001$), WOMAC Function improved from 43 at baseline to 11 at 2 years ($p<0.001$), and WOMAC Stiffness improved from 52 at baseline to 18 at 2 years ($p<0.001$). Patients reported satisfaction with implant and its appearance.

Conclusions

The KineSpring System provided pain relief and functional improvement in a young and obese patient population that may not be ideal for HTO or arthroplasty. This unloading device, with these successful results, fills a major gap in treatment options for young and active OA patients.

Figures

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Figure 1 HYPERLINK "http://app.istaonline.org/figures/459.jpg" \t "_blank"
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Figure 2

12A : Knee Mechanics: #545 September 23rd, 2011, 8:30-9:35

Feature-Based Bi-Planar RSA for Kinematic Analysis of Total Knee Arthroplasty

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Introduction:

The most common method for accurate kinematic analysis of the knee arthroplasty uses bi-planar fluoroscopy and model-based RSA. The main challenge is to have access to reverse-engineered CAD models of the implant components, if not provided by the company, making this method impractical for a clinical study involving many types or sizes of implants. An alternative could be to reconstruct the 3D primitive features of the implant, such as cylindrical pegs, flat surfaces and circular boundaries, based on their 2D projections. This method was applied by Kaptein et al. (2006) for hip implants. However, despite its broad potential, it has not yet been applied for studying TKA kinematics. This study develops a methodology for feature-based RSA of TKA and investigates the range of accuracies in comparison to model-based RSA.

Methods:

Joint-3D software was developed in the MATLAB programming language to segment and fit elementary 2D features such as circles, lines, and ellipses to the edges of the parts on the radiographs (Figure 1). The software has the capability to reconstruct the 3D location and orientation of the components based on their 2D projections.

To test the accuracy of the system a standard primary knee replacement system (Zimmer NexGen) was implanted on bone replica models, and positioned at 0° to 120° flexion at 30° intervals, simulating a lunge activity. For each pose, a multi-planar radiography system developed in our lab (Amiri et al., 2011) was used to take a sagittal and a 15° distally rotated radiograph (Figure 2a).

Figure 1 shows the features C, L, and E segmented on the tibia and femur. The 3D reconstruction is performed based on a number of functions: Functions '*f*' and 'g' reconstruct a 3D point or line based on their 2D projections. Function '*h*' finds the plane containing the 3D circular edge based on its two projection ellipses. Function '*i*' finds the 3D location of a line based on one projection line, and a known 3D vector normal to the solution 3D line. Based on these, the coordinate systems of the components were reconstructed (Figure 2b):

Femur_Origin=f(C1A,C1B);

Femur_Anteroposterior=g(L1A,L1B);

Femur_Proximodistal=g(L2A,L2B);

Femur_Mediolateral=i(L,C1A-C1B),{L=L1: if flexion<45°; L=L2: if flexion>45°};

E_3D=h(E1A,E1B);

Tibia_Origin=f(E1A_Centre,E1B_Centre);

Tibia_Anteroposterior=g(L3A,L3B);

Tibia_Mediolateral=cross(E_3D,Tibia_Anteroposterior);

Tibia_Proximodistal=cross(Tibia_Anteroposterior, Tibia_Mediolateral)

To determine the errors, model-based RSA measures were used as the reference using the reverse-engineered models of the components in JointTrack software (University of Florida).

Results:

The overall accuracies in terms of bias (the mean error) and precision (standard deviation of the errors) are shown in Figure 3. The bias was within 0.5-1 mm and 0.9-1.2°, and the calculated precision was in the range of 0.4-0.6 mm and 0.7-1.0°. The overall accuracy was 0.8±0.6 mm and 1±0.7°.

Discussion:

The very good accuracies obtained show the practicality of the methodology. The methodology can be easily worked out for any type of implant based on the primitive geometric features at the bone-implant interface. This method can be extremely useful in a large clinical study by eliminating the need for having the 3D models of many types and sizes of the implant available.

Figures

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Figure 3

6A : 3D planning and execution: #548 September 22nd, 2011, 8:30-9:35

ISO-C 3D Imaging of Component Alignment in Total Knee Arthroplasty

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Introduction:

Poor clinical outcomes following total knee arthroplasty (TKA) can be related to improper alignment of the components. The main challenge is the variability in biomechanical references, especially in cases of severe deformity or dysplasia, and in determining the surgical landmarks intraoperatively. An intraoperative imaging tool can be very useful to assess the alignments when there is still a chance for correction. We investigated, on cadaveric specimens, the accuracy of using iso-centric (ISO-C) imaging (that reconstructs 3D from multiple 2D fluoroscopic images) for this purpose.

Methods:

Six fresh frozen cadaveric knees were implanted with a standard TKA system and imaged using an ISO-C 3D C-arm (Arcadis Orbic ISO-C). Each knee was scanned two times with the Iso-C scanner and with appropriate image settings to capture the transepicondylar axis (TEA) and the tibial tubercle individually. A CT scan of each specimen was acquired as the reference for comparison.

The ISO-C 3D reconstructed volumes were analyzed on the C-arm. For the CT images, the 3D data were processed in Analyze software with the same objective. The surgical and clinical TEA was determined by moving and rotating an oblique cutting plane (Figure 1a:CT and 1c:ISO-C). This oblique slice was then moved distally to picture the femoral pegs (Figure 1b:CT and 1d:ISO-C). The angle between these two references (angle α in Figure 1) defined the rotational alignment.

For the tibial component, the first cutting slice was oriented parallel to the component. A second slice was defined just distal to the component, and then moved distally to find the tibial tubercle in the third slice. The orientation of the tibial component was determined by fitting a rectangular box to the component boundary (Figure 2a:CT and 2d:ISO-C). The bone orientation was defined by a line connecting the centroid of a polygon drawn over the boundary of the cortical bone (Figure 2b:CT and 2e:ISO-C) to the medial third of the tibial tubercle (Figure 2c:CT and 2f:ISO-C). Measurements were repeated five times, the overall accuracies determined in comparison to CT, and the correlation between the ISO-C and CT determined by the Spearman rank ($P<0.05$).

Results:

Correlation between the ISO-C and CT measures of the femoral and tibial alignments was statistically significant ($P=0.005$ and $P=0.018$) with corresponding correlation coefficients of 0.94 and 0.89 (Figure 3). The overall accuracies calculated for all of the specimens were $0.3° \pm 0.8°$ for the femoral component, and $0° \pm 1.4°$ for the tibial component. The calculated effective doses for the ISO-C imaging protocol of the femoral and tibial components were 0.005 mSv and 0.025 mSv respectively.

Discussion:

This study showed that it is feasible to use ISO-C imaging for assessing the alignment of TKA components with acceptable accuracy both intraoperatively and postoperatively. The intraoperative assessment of ISO-C can help improve the outcome of knee arthroplasty and avoid early revisions because of complications related to component alignments. Results showed that it is also possible to use the ISO-C imaging as a safer modality (i.e. less radiation dose) for investigating links between proper component alignment and post-arthroplasty complications.

Figures

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Figure 3

Optimizing UKA Designs

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No abstract available

13A : Robotics & navigation: #1099 September 23rd, 2011, 11:15-12:05

Developments in Technology to Improve the Treatment of Osteoarthritis

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No abstract available

12B : Hip arthroplasty: #1105 September 23rd, 2011, 8:30-9:35

The Usefulness of Computer-Assisted Cup-Positioning in Total Hip Arthroplasty

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Background:

Acetabular component malpositioning during hip arthroplasty increases the risk of dislocation, reduces range of motion and can be responsible for early wear and loosening. There have been numerous reports on the optimal orientation of the acetabular component in total hip arthroplasty (THA). Lewinnek et al recommended an abduction angle of 40°±10° and an anteversion of 15°±10° for cup alignment in THA. The purpose of the in vivo study was to compare computer assisted acetabular component insertion versus free-hand placement. The goal of the cadaveric study was to compare *in vitro* a new tool using ultrasound with the standard percutaneous manual methods for the anterior pelvic plane registration during computer-assisted total hip arthroplasty.

Methods:

A controlled randomized matched prospective study was performed in two groups of 30 patients. In the first group, cup positioning was assisted by an imageless computer assisted orthopaedics system, based on Bone Morphingâ (CAOS+ group). In the control group, a free-hand cup placement was performed (CAOS- group). A same cementless cup has been used in the two groups. All the patients were operated by the same surgeon through an anterolateral approach. Cup anteversion and abduction angles were measured on three-dimensional CT-scan reconstruction postoperatively for each patient by an independent observer with special cup evaluation software. In vitro,four clinicians were asked to register ten times in a randomly change order the anterior pelvic plane landmarks in four different acquisition conditions: a cutaneous acquisition, a draped cutaneous acquisition, ultrasound acquisition and a direct bone acquisition on two cadavers. The mean and standard deviation of error for each anterior pelvic plane acquisition method were expressed as rotation and tilt about the relevant reference plane and compared.

Results:

There were 16 males and 14 females in each group, the mean age was 62 years (24-80) and mean Body Mass Index was 25. Mean additional time of the CAOS procedure was 12 minutes (8-20). Intraoperative subjective agreement of the surgeon with the computer guidance system demonstrated a high correlation in 23 cases, weak correlation in 6 cases and a poor correlation in 1 case. There were no statistical differences between the CAOS+ group and the CAOS- group regarding means of the abduction and anteversion angles but a significant heterogeneity of variances, with the lowest variations in the CAOS+ group**.** In vitro, for the draped cutaneous acquisition method the mean of the rotation and tilt around the reference plane for the two cadavers and the four operators were respectively 3.8 °±0.21° and 19.25 °±4.1°, for the for the ultrasound acquisition method respectively 2.8 °±0.21° and 6.2 °± 4.1°, for the cutaneous acquisition method respectively 2 °±0.21° and 16.2 ° ±4.1°.

Discussion:

The in vivo study has shown the accuracy of cup positioning using a CT-free navigation system in a prospective randomized controlled protocol. Based on the number of the cadaveric study, ultrasound acquisition of the anterior pelvic plane is more accurate, reliable and reproducible in vitro than actual cutaneous digitization.

10A : Navigation: #682 September 22nd, 2011, 16:40-17:30

The Effect of Distal Femoral Cut Height on Coronal Plane Stability in TKA: A Cadaveric Study Assessing the Effect of Re-Cutting the Distal Femur

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Aims/Hypothesis:

The aims of this study were: 1) to quantitatively analyse the amount of knee extension that is achieved with +2mm incremental increases in the amount of distal femoral bone that is resected during TKA in the setting of a flexion contracture, 2) to quantify the amount of coronal plane laxity that occurs with each 2mm increase in the amount of distal femur resected. In the setting of a soft tissue flexion contracture, we hypothesized that although resecting more distal femur will reliably improve maximal knee extension, it will ultimately lead to increased varus and/or valgus laxity throughout mid-flexion.

Methods:

Seven fresh-frozen cadaver legs from hip-to-toe underwent TKA with a posterior stabilized implant using a measured resection technique with computer navigation system equipped with a robotic cutting-guide, in this IRB approved, controlled laboratory study. After the initial tibial and femoral resections were performed, the posterior joint capsule was sutured (imbricated) through the joint space under direct visualization until a 10° flexion contracture was obtained with the trial components in place, as confirmed by computer navigation. Two distal femoral recuts of +2mm each where then subsequently made and after the remaining femoral cuts were made, the trail implants were reinserted. The navigation system was used to measure overall coronal plane laxity by measuring the mechanical alignment angle at maximum extension, 30°, 60° and 90° of flexion, when applying a standardized varus/valgus load of 9.8 [Nm] across the knee using a 4kg spring-load located at 25cm distal to the knee joint line.(Figure 1) Coronal plane laxity was defined as the absolute difference (in °) between the mean mechanical alignment angle obtained from applying a standardized varus and valgus stress at 0°, 30, 60° and 90°. Each measurement was performed three separate times and averaged.

The maximal extension angle achieved following each 2mm distal recut was also recorded. Two-tailed student's t-tests were performed to analyze whether there was difference in the mean laxity at each angle and if there was a significant improvement in maximal extension with each recut. P-values < 0.05 were considered significant.

Results:

For a 10° flexion contracture, performing the first distal recut of +2mm increased overall coronal-plane instability by approximately 3° at 30° and 60° of flexion ($p < 0.05$).(Figure 2) Performing the second recut of +4mm further increased mid-flexion instability by another 2° ($p < 0.01$).(Figure 2) Maximum extension increased from 10° of flexion to 6.4° (±2.5° SD, $p < 0.005$) and to 1.4° (±1.8° SD, $p < 0.001$) of flexion with each 2mm recut of the distal femur.

Conclusions:

Using a reliable, accurate, and reproducible method of measuring coronal plane laxity and maximal knee extension, we have shown that in the setting of a flexion contracture or tight extension space during TKA, recutting the distal femur by 2 mm will effectively increase the amount of maximal extension by 4°; however, as a secondary effect, recutting the distal femur by 2 mm will also lead to 2.5° of increased coronal plane laxity in midflexion.

Figures

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Figure 2

11A : Knee kinematics: #1107 September 22nd, 2011, 17:40-18:30

Kinematics and Coronal Plane Stability Between a Posterior Stabilized vs Bicruciate Stabilized vs

Ultracongruent Total Knee Arthroplasty

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Claus Egidy - Hospital for Special Surgery - New York, USA
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Purpose

Our aim was to compare the passive kinematics and coronal plane stability throughout flexion in the native and the replaced knee, using three different TKA designs: posterior stabilized (PS), bi-cruciate substituting (BCS), and ultracongruent (UC). Our hypotheses were: 1.) a guided motion knee replacement (BCS) offers the closest replication of native knee kinematics in terms of femoral rollback 2.) the replaced knee will be significantly more stable in the coronal plane than the native knee; 3.) No difference exists in coronal plane stability between the 3 implants/designs throughout flexion.

Methods

After IRB approval, two cadaveric specimens were used for a pilot study to determine sample size. Five fresh-frozen hip-to-toe cadaveric specimens then underwent TKA using an anatomic measured resection technique with a computer-navigated robotic femoral cutting-guide. The PS, BCS, and UC TKA designs were implanted in each knee using the same distal and posterior femoral cuts to standardize the position of the implants. Computer navigation was then utilized to record the varus/valgus laxity of each implant at 0°, 30°, 60° and 90° of flexion while applying a standardized 9.8Nm moment.

Passive tibiofemoral kinematics were measured in a continuous passive motion machine from 10º to 110º. Femoral rollback on the tibia was calculated for the native and replaced knees by measuring the closest point (CP) on the femoral condyle to a transverse plane perpendicular to the mechanical axis of the tibia at each flexion angle.

Results

Average coronal plane laxity increased with flexion from 0º-90º in the native and replaced knees. All three knee implant designs had comparable varus/valgus laxity throughout flexion with maximum differences between designs of <1º-2º, but were all more stable on average than the native knee at all flexion angles. The BCS design matched the native knee kinematics most closely, but exhibited more posterior translation and "sliding" of the femoral condyles on the tibial insert than observed in the native knee.

Conclusions:

BCS TKA exhibited passive knee kinematic patterns that most closely resembled the native knee but with more femoral rollback. All three knee implant designs had comparable varus/valgus laxity throughout flexion, but were all more stable on average than the native knee throughout flexion.

9A : Future technologies: #991 September 22nd, 2011, 14:55-15:45

Hip Arthroscopy in Post-Arthroplasty Patients

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Background:

Hip arthroscopy is well established as a diagnostic and therapeutic tool in the native hip joint. However, its application in the symptomatic post-hip arthroplasty patient is still being explored.

Aims and Methods:

We have described the use of hip arthroscopy in symptomatic patients following total hip replacement, resurfacing hip arthroplasty and partial resurfacing hip arthroplasty in 24 patients (study group), and compared it with

arthroscopy of the native hip of 24 patients.

Results:

The diagnostic yield of hip arthroscopy in symptomatic post-arthroplasty patients was 95.8% (23 / 24) and a therapeutic arthroscopic intervention resulted in relief of symptoms in 41.6% (10 / 24) of the patients. It led to revision hip replacement in a further 29.1% (7 / 24). In contrast, hip arthroscopy of the native hip (control group) had a 100% diagnostic yield and an arthroscopic therapeutic intervention was carried out in all the patients resulting in symptomatic relief in 87.5% (21 / 24). The mean operative time in the study group (59.7 mins, SD 21.1) was less than the control group (71 mins, SD 17.1, $p < 0.05$) but the arthroscopic approach was more difficult.

Conclusion:

The authors suggest the use of hip arthroscopy in well-investigated symptomatic post-arthroplasty patients with an elusive diagnosis (Fig. 1: Arthroscopic image showing a THR *in situ* (Furlong, JRI, London, UK) with a ceramic femoral head (yellow arrow), ceramic acetabular liner (white arrow), florid metallosis (red arrow) and corrosion on the femoral neck (green arrow) because of impingement against the margin of the acetabular component.**)** and also describe the technical modifications necessary with various types of hip arthroplasty.

Figures

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Figure 1

1A : Kinematics and Wear-knee: #915 September 21st, 2011, 8:30-9:35

Rationale, Implant Design and in Vivo Kinematics for a Multi-Compartmental Knee Arthroplasty System

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Michael Conditt - Mako Surgical - Boerne, USA
Nicholas Dunbar - University of Florida - Gainesville, USA
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Stefan Kreuzer - Memorial Bone and Joint Research Foundation - Houston, USA
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There is great interest to provide repeatable and durable treatments for arthritis localized to one or two compartments in the cruciate-ligament intact knee. We report a series of efforts to develop and characterize an implant system for partial knee resurfacing. We studied distal femoral morphology and found that the sagittal-plane relationships between the condylar and trochlear surfaces are highly variable (Figs 1 and 2). In response, we report the design of a multi-compartmental system of implants intended to anatomically resurface any combination of compartments (Fig 3). Finally, we report the results of a pilot fluoroscopic study of the in vivo knee kinematics in patients who received medial, medial plus patellofemoral and bi-condylar knee arthroplasty. The kinematic results suggest these treatments provide a stable knee with intact cruciate ligament function. This work shows various partial knee resurfacing treatments have the potential to provide excellent knee mechanics and clinical outcomes.

Note - A full paper was submitted for consideration of the Hap Paul Award. The figure legends and numbers in the attached figures correspond to those in the full paper.

Figures

10A : Navigation: #1008 September 22nd, 2011, 16:40-17:30

Tactile-Guided Unicompartmental Knee Arthroplasty: Clinical Accuracy

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Introduction

Unicompartmental knee arthroplasty (UKA) can achieve excellent clinical and functional results for patients suffering from single compartment osteoarthritis. However, UKA is considered to be more technically challenging to perform, and malalignment of the implant components has been shown to significantly contribute to UKA failures. The purpose of this investigation was to determine the clinically realized accuracy of UKA component placement using surgical navigation and dynamically referenced tactile-robotics.

Methods

Pre-op CT, post-op CT, and surgical plan were available for 22 knees out of the first 45 procedures performed using a new tactile-guided robotic system. 3D component placement accuracy was assessed by comparing the pre-operative plan with the post-operative implant placement (desired versus actual). Bone and implant models were obtained from postoperative CT scans taken immediately following the surgery. A 3D to 3D iterative closest point registration procedure was performed and the measured implant position was directly compared to the preoperative plan. Errors were assessed as single axis root-mean-square (RMS) entities.

Results

Femoral component RMS placement errors averaged 1.4 mm/2.6º along any single axis. Tibial component RMS placement errors averaged 1.18 mm/2.14º along any single axis.

Conclusion

Using traditional manual instruments, Cobb et al. found average RMS errors of 2.20mm/5.48º. Using the robotic approach with bones fixed, Cobb et al. reported RMS errors of 1.11 mm/2.5º, directly comparable to our results with bones moving freely during surgery. Varus/valgus femoral component alignment and posterior tilt of the tibial component are within the accepted range to prevent excessive edge loading, leading to tibial plateau collapse and/or excessive wear. Dynamically-referenced tactile robotics provide a new tool to accurately prepare bone with minimally invasive approaches. Our results suggest excellent UKA implant placement accuracy can be achieved, comparable to that demonstrated for statically referenced tactile robotics. The patients were the first group from a single surgeon using this technique, suggesting good implant alignment is achieved in what normally would be considered a learning phase. Finally, these patients were treated with the first approved version of this new tool, suggesting further refinement of this robotic technology will enhance the accuracy and usability of this tool.

2A : CAOS session: #1036 September 21st, 2011, 11:15-12:05

Smart-Instruments for Navigated Freehand Bone Cutting - Hands Free Automatic Laser Bone Marking: On-Tool Marker (OTM)

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Introduction:

Navigated freehand cutting (NFC) technology simplifies bone cutting in laboratory trials by directly navigating implants and power tools [1]. Experiments showed that NFC bone cutting was faster than with conventional jigs. However, most delays occurred at the start of each cut [2]. Therefore, we further reduced starting times and

gained more accuracy with a NaviPen and a 'smart' NaviPrinter [3]. There were used to physically mark a line on the bone surface indicating where each cut should start. **(Fig_1)**. Further gains are targeted with our introduction of the On-Tool Marker (OTM); a touch-less laser marking technology as a standalone device or mounted on the cutting instrument (e.g. on the saw). The OTM points the desired cut by projecting a laser image on the bone. That image (usually a line or cross) changes dynamically, so that for any given cut the line projection remains stationary on the bone regardless of the relative location of the device.

Materials & Methods:

The OTM is a standalone wireless module composed of three main parts: a small laser projector, electronics for control and communication (WiFi), and a tracking frame. It is navigated in real-time with a Polaris tracker. Software routines on a proprietary NFC system compute its relative position to the target and dynamically re-calculate the image parameters. Such parameters are sent to the OTM for processing, image generation, and projection **(Fig_2)**. Bandwidth and data integrity were evaluated through bench tests. To assess accuracy of the projection, a target planar cut was defined on a flat surface (a line drawn on grid paper pasted to a navigated board), and the NFC system was fed with this geometrical information. The OTM was moved within a volume of ~50cm in diameter (distance to the target plane from 5cm to 50cm), and at various angles up to +/- 80º (in roll, pitch and yaw). The projected line should coincide with the target line on paper regardless of the relative positioning of the OTM. Errors (target vs. projected) were measured on the grid paper.

Results:

Well-defined lines were projected at a rate of 17fps. Projected lines remained within +/- 2 mm from the target (average ~0mm). Errors, largely caused by a lag in the images, were unperceivable after a fraction of a second if OTM remained still. Among different colors tested, green was the most suitable, based on brightness and visibility **(Fig_3)**.

Discussion and Conclusion:

A 'smart' navigated laser marker was successfully created and tested. The limited refresh speed and lag was not much of a concern, as common use would not require fast motion. However, further work will focus on improving these, and devise solutions for projection on non-planar bone models. OTM would speed the surgery more as it saves the time to use the NaviPen or the NaviPrinter. We estimate this can reach 2-3 minutes based on some preliminary experiments we conducted and not reported here. Finally, OTM can help reduce the number of instruments in surgery even further (less inventory, less sterilization, less cost and less worries).

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Figures

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Figure 3

10A : Navigation: #684 September 22nd, 2011, 16:40-17:30

Using Computer Knee Navigation to Measure Genu Recurvatum

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Introduction:

Genu recurvatum is a deformity rarely seen in patients receiving total knee arthroplasty. This deformity is defined as hyperextension of the knee greater than 5°. The incidence of recurvatum has been cited in the literature as less than 1%.

Purpose:

The purpose of this study was to report data on 1510 consecutive total knee replacements (TKR) with navigation to demonstrate that the incidence of genu recurvatum is higher than what is cited in the literature.

Methods:

This is a retrospective review that was approved by our health science institutional review board. We reviewed resting, intra-operative alignment of 206 navigated total knee arthroplasty cases with recurvatum. This is data from 4 surgeons who are lower extremity joint replacement physicians. The range of motion (ROM) is measured and recorded by the attending physician during routine physical examination of the lower extremity. Demographic data was used to describe the patient group. The data will include pre-operative, intra-operative and post-operative ROM. The intra-operative data will be captured by the navigation system, this sytem is accurate to 1° and 1mm. The post-operative ROM will be obtained from an office visit. We are interested in the post-operative ROM to demonstrate correction of the recurvatum.

Results:

One thousand five hundred and ten primary TKR were reviewed for this study. Two hundred and six patients (13.6%) had genu recurvatum as measured by the navigation computer. The range of recurvatum was 0.5 – 30°; mean 5 degrees (STD 4.3º). Sixty six patients had $\geq$5 degrees of recurvatum (4.4%). Only 2 patients had recurvatum recorded on their pre-operative office visit. These 2 patients did not have extreme recurvatum, 3º and a few degrees on walking respectively. No patient had recurvatum at the 4 year visit (visit range 3 months – to 4 years). The primary diagnosis for the group was osteoarthritis, 92 %. All cases of recurvatum were treated with under resection of the femur and correction of the coronal plane. All cases were corrected intraoperatively.

Conclusion:

Etiology of recurvatum can be due to bony insufficiency at the anterior tibia, insufficiency at both femoral condyles or laxity of the posterior capsule and ligaments. During surgery this can be addressed by under resection of the femur and undersizing the femoral component to increase the flex space, or soft tissue tightening can be implemented. Our surgical technique aimed to balance hyperextension with reduction of the distal femoral cut. Coronal balance is also important in the management of hyperextension. Current total knee designs lack the extension cam effect and make sagital balancing critical. Recurvatum is difficult to correct after total knee arthroplasty and this issue is important to address at the time of primary surgery.

The use of a navigation system helped us appreciate a deformity that is not easily detected during routine examination. This study found that genu recurvatum in patients receiving TKR is significantly higher than what is reported in the literature. This finding has important implications for the management of a small percentage but nonetheless significant number of patients. This deformity is not appreciated in the clinical setting during routine examination.

Keynote Lecture 9 : Ultimate Balancing by Leo Beckers: #968 September 22nd, 2011, 16:25-16:40

Ultimate Balancing

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IN THE PAST success of TKA has been measured by ROM with maximum flexion as a bench mark, along with good stability of the knee joint MAINLY IN EXTENSION. Due to changing demographics our TKA population has shifted to more active and demanding patients which want to return to normal daily living, including professional and recreational sports activities.

With the patella in place, we define a ligament “balanced resection” technique using the elibra device, and are able to optimize our results and meet younger, more active patient’s expectations.

Our workflow consists of a flexion gap first technique, maximizing posterior condylar offset, hence maximizing flexion with optimal ligament balance.

This flexion gap is then transmitted to the extension gap, initially using custom made spacer blocks either neutral or angled in 1°, 2° or 3° applied to the elibra sensing device and more recently by using a specific designed extension gap balancer.

The immediate and short term postoperative observations concerning femoral component rotation, patellar tracking, influence of patella in place versus subluxed on flexion gap balance, varus-valgus alignment and complete mitigation of ligament releases will be discussed.

3A : Navigation: #399 September 21st, 2011, 13:50-14:40

Joint Line Changes in Cruciate-Retaining Versus Posterior-Stabilized Computer Navigated Total Knee Arthroplasty

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Purpose

The purpose of this study was to compare joint line changes between posterior-stabilized (PS) and cruciate-retaining (CR) computer navigated total knee arthroplasties (TKA) and to evaluate the impact on functional outcome.

Background

Restoration of the native joint line has been a common goal in all TKA designs. Computer-navigated TKA in increasingly being favoured by many surgeons, due to increased precision and lesser complications. Few studies have reported the effect of computer navigated TKA on joint line restoration. It remains to be seen if the greater precision offered by computer-navigated TKA in restoration of joint line translates to improvement in functional outcome.

Methods

This study assessed joint line changes following computer-assisted navigated total knee arthroplasty (TKA). A total of 195 patients were followed up for a period of 2 years following primary surgery. The change in the joint line was calculated based on the verified bony resections and the final thickness of the insert. The patients were stratified into two groups: the CR group and the PS group. The joint line changes of both groups were then compared using the Student t-test. Multivariate analysis and regression modelling were then utilized to analyze the functional outcomes of both groups at 6 months and 2 years of follow-up.

Results

A total of 112 CR knees and 83 PS knees were analyzed. PS knees had a significantly greater joint line change as compared to CR knees with a p-value of 0.04 (Figure 1). Although the knee, function and oxford knee questionnaire scores were significantly better in the CR group at the 6-month follow-up, this did not translate into any significant difference in functional scores at the 2-year follow-up. It was also found that the PS group had significantly better final range of motion.

Conclusion

CR knees are associated with significantly less joint line changes than PS knees in computer navigated TKA. PS knees have a greater range of motion at 2 years of follow-up. No significant difference in outcome was noted at 2 years follow-up.

Figures

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Figure 1

12B : Hip arthroplasty: #896 September 23rd, 2011, 8:30-9:35

Analysis of Failed Hemiarthroplasty Hip Prostheses

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Background

Hemiarthroplasty of the hip involves the replacement of the femoral side of the joint with a metal prosthesis, resulting in metal-on-cartilage articulation. The two most common types of hemiarthroplasty used are the Austin Moore and the Thomson, both of which are available in either Titanium (Ti) or cobalt chromium (CoCr). Hemiarthroplasty may be more cost effective in elderly patients who have lower life expectancy and are less active.

Materials and Methods

Three Ti and two CoCr hemiarthroplasty components were obtained following revision surgery. Four had an articulating diameter of 44mm and the other was 46mm diameter. These five hemiarthroplasties were analysed using a Mitutoyo LEGEX322 co-ordinate measuring machine (CMM) (manufacturer's claimed scanning accuracy of 0.8μm). In each case a wear map was generated and the wear volume from the articulating surface was calculated using a bespoke MATLAB program.

Results

The two CoCr prostheses had wear volumes of 1.3mm^3 and 7.8mm^3, while the three Ti prostheses had wear volumes of 85.4 mm^3, 16.3 mm^3 and 17.4 mm^3.

Figure 1: CoCr Prosthesis with a small wear scar at the rim

Figure 1 shows the location of the wear mark on the bottom edge of the CoCr prosthesis, with a volumetric wear of 1.3 mm^3, and also some scratching at the pole. The maximum wear depth was 0.0082mm.

The second CoCr prosthesis also showed small localised wear marks over the surface and at the pole giving a total wear volume of 7.8mm^3 and a maximum linear wear depth of 0.016mm.

Figure 2: Ti Prosthesis with large wear

Figure 2 shows the Ti prosthesis with the highest wear volume of 85.4 mm^3. The worn area (shown in blue) extended over much of the articulating surface area and the maximum linear depth was 0.080mm.

The second Ti prosthesis (the only sample of 46mm diameter) had a wear volume of 16.3 mm^3 and a maximum linear wear depth of 0.045mm.

Figure 3: Ti Prosthesis with wear mark at the pole

The third Ti prosthesis analysed (shown in Figure 3) had a wear volume of 17.36 mm^3. Unlike the others the wear was concentrated at the pole where the linear wear depth was 0.060mm.

Discussion

To the authors' best knowledge they are unaware of any other volumetric wear studies on explanted hemiarthroplasties. The CoCr hemiarthroplasties showed lower wear volumes and smaller linear wear depths than the Ti prostheses. The location of the wear marks on the articulating surface varied between the retrieved prostheses.

These results suggest that Ti hemiarthroplasties are wearing more than CoCr prostheses. It is unknown what effect the two different types of prostheses have upon the cartilage of the acetabulum, or whether there is any difference in the damage they cause.

Given the results obtained, and the known negative effects of particulate wear debris in the body questions should be asked regarding the suitability of Ti for use in hemiarthroplasty.

Figures

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Figure 6
: #1094 , 0:00-0:00

Patient-Specific Knee Arthroplasty - Component Sizing Affects Outcome

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No abstract available

8A : Knee arthroplasty: #1119 September 22nd, 2011, 13:55-14:45

TKA and Extra-Articular Deformity

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No abstract available

6A : 3D planning and execution: #505 September 22nd, 2011, 8:30-9:35

Accuracy of Pre-Operative Planning in Robot-Assisted Unicompartmental Knee Arthroplasty

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Introduction

Unicompartmental knee arthroplasty (UKA) was first described over 30 years ago and allows replacement of a single compartment in patients who have isolated osteoarthritis.[1] However, UKA is more technically challenging than total knee arthroplasty due to limited exposure as a minimally invasive procedure. In addition to component alignment and fixation, ligament balancing plays an important role in implant survival.[2] Some failures of early UKA systems were attributed to a failure to adequately balance the knee. The development of robots to aid in performing the procedure has lead to renewed interest in this surgical technique.

The use of a robot-assisted system allows the orthopaedic surgeon to verify that balancing sought pre-operatively correlates with that obtained at surgery. Some studies have shown good post-operative mechanical alignment utilizing this method.[3] The aim of this study was to examine the variation in pre-operative templated ligament balance and that obtained during the operation.

Methods

Data were prospectively collected on 52 patients (51 knees) undergoing robot-assisted unicompartmental knee arthroplasty by a single surgeon. For pre-operative planning, dynamic ligament balancing was obtained of the operative knee under valgus stress, prior to any bony cuts. Final intra-operative images with the prosthesis in

place were taken without valgus stress. Positive values denoted loose ligamentous balancing while negative values indicated ligament tightness.

Results

A small variation of less than 1 mm was measured between the pre-operative plan and the final image with the implant in place. At 0 degrees the mean change was -0.26 mm (range, -4.40 to 2.20 mm), at 30 degrees -0.53 mm (range, -5.30 to 1.80 mm), at 60 degrees -0.04 mm (range, -3.10 to 2.30 mm) and at 90 degrees 0.16 mm (range, -2.70 to 2.00 mm). These results show that planned dynamic ligament balancing is accurate to within 0.52 mm.

Conclusion

The technological advancements with robotic feedback in orthopaedic surgery can aid in the success of unicompartmental knee replacement surgery. Ensuring that pre-operative templated changes match those performed during surgery is an important predictor of outcome. With proper planning prior to surgery, the use of a robot in UKA can improve ligament balancing. This can be done at various angles, ensuring excellent ligament balancing throughout the entire range of motion. Correct component alignment reduces the risk of prosthetic failure and may increase the length of implant survival. Further fine-tuning of the accuracy of feedback between the robot and the anatomical points will improve the accuracy of UKA.

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13B : Hip arthroplasty: #1002 September 23rd, 2011, 11:15-12:05

Accuracy of Robotic Arm Assisted Acetabular Cup Implantation

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INTRODUCTION

Total hip arthroplasty (THA) is regarded as one of the most successful surgeries in medicine. However, recent studies have revealed that ideal acetabular cup implantation is achieved less frequently than previously thought, as little as 50% of the time. It is well known that malalignment of the acetabular component in THA may result in dislocation, reduced range of motion, or accelerated wear. This study reports accuracy of a tactile robotic arm system to ream the acetabulum and impact an acetabulur cup compared to manual instrumentation.

METHODS

12 fresh frozen cadaveric acetabulae were pre-operatively CT scanned and 3D templating was used to plan the center of rotation, and anteversion and inclination of the cup. Each specimen received THA, six prepared manually and six prepared with robotic arm guidance. Tactile, visual, and auditory feedback was provided through robotic guidance as well as navigated guided reaming and cup impaction. The robotic guidance constrained orientation of instruments thus constraining anteversion, inclination, and center of rotation for reaming, trialing, and final cup impaction. Post-operative CT scans were taken of each specimen to determine final cup placement for comparison

to the pre-operative plans.

RESULTS

In all cases, robotic arm guidance resulted in ±4° of anteversion and ±5° of inclination each relative to the pre-operative plan. Absolute RMS errors were 2.16 ± 1.35° for anteversion and 1.91 ± 1.55° for inclination. Cup placement with robotic guidance was significantly more accurate and precise than placement with manual instruments. With manual instrumentation the errors were, on average, 4.0 times higher in anteversion and 5.9 times higher in inclination compared to robotic instrumentation.

CONCLUSION

This tactile robotic system substantially improved the accuracy of acetabular reaming and placement of the final cup compared to traditional manual techniques. With greater knowledge of ideal acetabular cup position, highly accurate techniques may allow surgeons to decrease the risk of dislocation, promote durability and improve the ability to restore appropriate leg length and offset. Tactile robotics has proven to be safe and effective in both knee and hip surgery and provides the potential to redefine the "instrument set" used for orthopedic procedures.

Finite Element Study of Augmented Total Knee Replacement

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Introduction:

In complex primary and revision total knee replacement (TKR) the operating surgeon may encounter proximal tibial bone defects. The correct management of such defects is fundamental to both the initial stability and long-term survival of the prosthesis. Cement or metal augments have been used to address some such type II unconstrained defects [1].

Aim:

The aim of this finite element (FE) study was to analyse the comparative behaviour of cement and metal based augments and quantify the stresses within these different augments and underlying cancellous bone.

Materials and methods:

A three-dimensional FE model was constructed from a computer tomography (CT) scan of the proximal tibia using SIMPLEWARE v3.2 image processing software. The tibial component of a TKR was implanted with either a block or wedge-shaped augment made of either metal or cement. The model was axially loaded with a force of 3600N and testing was conducted with both evenly and eccentrically distributed loads.

Results:

Upon loading the FE model, the von-Mises stresses in the cancellous bone underneath the augments were found to be higher with cement based augments in comparison their metal based counterparts. This was evident with both block and wedge-shaped augments. The FE model demonstrated that compressive stresses within the metal based augments were greater than those within the cement based augments. This was evident with both block and wedge designs. Upon even loading the maximum recorded compressive stresses within the metal augments were 5 times less than the endurance limit of the material [3]. However, the maximum recorded compressive stresses within cement augments were only half the endurance limit of the material [4] and upon eccentric loading compressive stresses in excess of the endurance limit were recorded.

Discussion:

The FE model has demonstrated that cement based augments undergo a greater deformation when loaded and therefore transfer greater loads to the underlying cancellous bone. This is a result of the inherent flexibility of the cement based augment in comparison to the stiffer metal counterparts. The greater transference of load to cancellous bone with cement based augments may reduce the possibility of stress shielding. However, the compressive stresses within cement based augments are too close to the endurance limit of the material and with uneven loading even exceed it. This would imply that cement based augments are more prone to fatigue failure than their metal counterparts.

Conclusion:

This FE study supports the use of metal based augments over cement based augments in augmented and revision TKR surgery.

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12A : Knee Mechanics: #719 September 23rd, 2011, 8:30-9:35

Reverse Shear Stresses in Augmented Total Knee Replacement

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Introduction:

In complex primary and revision total knee replacement (TKR) the operating surgeon may encounter proximal tibial bone defects. The correct management of such defects is fundamental to both the initial stability and long-term survival of the prosthesis. Block or wedge-shaped metal augments are used to address some such type II unconstrained defects[1].

Aim:

The aim of this finite element (FE) study was to assess the effects of block and wedge-shaped metal augments upon the shear stresses in the cement mantle at the bone-implant interface of an augmented TKR.

Materials and methods:

A three-dimensional FE model was constructed from a computer tomography (CT) scan of the proximal tibia using SIMPLEWARE v3.2 image processing software. The tibial component of a TKR was implanted with either a block or wedge-shaped metal augment *in-situ*. The model was axially loaded with a force of 3600N, equating to four times the body weight of a 90kg patient, and the load evenly distributed between the medial and lateral tibial plateaux.

Results:

Upon loading of the FE model, shear stresses in the cement-augment interface were found to act towards the centre of the prosthesis. The maximal magnitudes of these 'reverse' shear stresses were 3.6MPa with a block-shaped augment and 2.6MPa with a wedge-shaped augment. These values are significantly lower than the reported fatigue limit of cement of 17MPa[2].

Discussion:

Initially it might appear surprising that the cement shear stresses with the wedge-shaped augment are lower than those with the block-shaped augment. However, the FE modelling has shown that in both cases the implant and cement act to prevent the cortical and cancellous bone from expanding when loaded vertically thus inducing a shear stress at the cement-augment interface acting towards the centre of the prosthesis. The angled loading induced by a wedge-shaped augment creates shear stress acting away from the centre of the prosthesis thus

reducing the overall cement shear stress in the wedge augmented model.

Conclusion:

The FE model has demonstrated reduced cement shear stresses with a wedge-shaped rather than block-shaped augment. However, both values of maximal recorded shear stresses are below the fatigue limit of cement[2]. Therefore, either a wedge or block-shaped augments can be used and the choice of augment may be determined by the shape of the defect and the quality of the underlying bone.

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Wear of Ceramic-on-Carbon Fibre Reinforced PEEK Hip Replacements

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Introduction

Concerns regarding UHMWPE wear particle induced osteolysis in total hip replacement (THR, [1]) have led to alternative materials to be sought. Carbon-fibre reinforced poly-ether-ether-ketone (CFR-PEEK) has shown reduced wear in hip and knee configurations compared with conventional polyethylene [2-4]. The aim of this study was to investigate the wear performance of a ceramic-on-CFR PEEK THR through a simulator study.

Methodology

Five 36mm diameter Biolox Delta heads were paired with extruded CFR-PEEK cups and tested in a hip wear simulator (Simulator Solutions, UK) for 10 million cycles (Mc). Tests were performed in a Prosim hip simulator, which applied a twin peak loading cycle, with a peak load of 3kN. Flexion-extension of -15 to +30 degrees was applied to the head and internal-external rotation of +/- 10 degrees was applied to the cup, components were mounted anatomically. The lubricant was 25% (v/v) calf serum supplemented with 0.03% (w/v) sodium azide. Wear was assessed gravimetrically at several intervals adjusted for moisture uptake using loaded and unloaded soak controls.

Results

The volumetric wear of the CFR-PEEK cups was calculated from weight loss, corrected for fluid uptake by a mean value of the loaded and unloaded soak controls. The CFR-PEEK bearings exhibited step-like wear behaviour throughout the study (Figure 1), with periods of 'higher' wear rate (between 0.4mm – 1.4mm^3/Mc) and periods of a 'lower' wear rate (less than 0.4mm^3/Mc), a phenomenon that has previously been observed with this material [3]]).

Discussion

The wear of a novel ram-extruded CFR-PEEK cup, articulating with a Biolox Delta ceramic head was assessed through a 10Mc experimental wear study. The mean wear rate over the period of the study was very low, with less than 1mm^3/Mc measured. The wear rates observed in this study are comparable with reported wear rates for 36mm diameter hard-on-hard bearings [5], and lower than wear rates measured for a highly cross-linked polyethylene bearing [6]. The wear rates reported in this study are lower than those previously reported [3], however, as CFR-PEEK operates within a boundary lubrication regime, the reduced head diameter in the present study would result in reduced sliding distance and lower surface wear.

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Figures

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Figure 1

Robotic Assisted Surgeries: Six Years Clinical Experience With Spine Assist Platform

*Alexander Bruskin - Lady Davis Carmel Medical Center - Haifa, Israel
Vitaly Alexandrovsky - Lady Davis Carmel Medical Center - Haifa, Israel
Benjamin Berenfeld - Lady Davis Carmel Medical Center - Haifa, Israel
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Robotic assisted spine surgery was a breakthrough in the evolution of spinal surgery, gradually gaining its place as an alternative technique for conventional spinal procedures. As the general population's life expectancy increased so does the incidence of spinal pathology and with it emerged an urging need for a safer and more accurate means of treatment.

In our institute we apply the "Spine Assist" platform for a variety of spinal procedures as Vertebroplasties, biopsies, Pedicular screws insertion and an inter-vertebral fusion – GOLIF procedures.

This study is designed to analyze the learning curve of each procedure, regarding the amount of fluoro images (**FI**) taken, fluoro exposure (**FE**) time and net operation time.

All spinal procedures using the "Spine Assist" platform were included in this study; all took place from 2006 until September 2010.

Exclusion criteria were procedures with failed pre-op registration, and robotic assisted procedures that were converted to conventional fluoroscopic assisted during the operation.

Every single surgery of all types of procedures was analyzed regarding the amount of FI taken, FE time and net operation time. Pedicular screws insertion was grouped into sets of four, where the same parameters were evaluated.

Altogether we preformed 106 robotic assisted Vertebroplasty procedures. During this period a distinct learning curve was observed and analyzed. For the first ten Vertebroplasties an average of 12 FI were taken with a net operation time of 53.6 min per procedure. Analyzing the first 40 procedures has shown less FI per procedure (5 FI) and a net operation time of 48.6 min/procedure. Data drawn from the 51 following Vertebroplasties has set the standards of 4 FI with a net operation time of 25.6 min/procedure.

Two Vertebroplasty procedures were not completed due to failure of software registration.

Pedicular screws are a mean for stabilization of vertebral motion units. During a six years period 706 screws were inserted, out of whom 98 were inserted using percutaneous technique. Comparing the insertion of a set of 4 screws we found a significant improvement regarding the number of FI, FE time and the net operation time

between the first ten procedures and the rest with a mean of 20 FI /4 FI and net screw insertion time of 82 min/ 25 min respectively. We found no difference in the parameters comparing percutaneous Vs open Pedicular screws insertion.

The mean accuracy of all procedures was 0.3 mm compared to the pre planned screw trajectory. No false route was detected in any of the 506 procedures.

This robotic assisted technique is a new and safe approach aiming to shorten the duration of the procedure, thus reducing the patient and surgeon exposure to radiogenic dose. The essence of robotic assisted surgery is a pre planned needle/screw trajectory aiming to reduce the possible intra-operative complication, inaccuracies and possible mishaps emerging during "free hand" procedures.

Gaining more experience using the spine assist platform, as shown in this detailed learning curve, enabled us to leverage the platform for ultra-accurate procedures as the percutaneous intervertebral fusion – GOLIF, Vertebroplasty for burst fractures etc.

12B : Hip arthroplasty: #913 September 23rd, 2011, 8:30-9:35

Total Hip Replacement in Obese Patients Enrolled in an Enhanced Recovery Programme

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Introduction

Obesity is a direct contributor to degenerative joint disease, and as the prevalence of obesity increases globally it is likely that more overweight patients will present for hip replacement surgery. There are reports that overweight patients in the UK's National Health Service, typically with a Body Mass Index (BMI) over 30 (BMI 30-39 obese, BMI≥40 morbidly obese), are being denied operations on the premise that they are at risk of significant complications. Enhanced Recovery Programmes (ERP) are designed to enable patients to recover quickly and return home safely within a few days. The aim of this study was to compare the outcome of hip replacements in obese and non-obese patients enrolled in our ERP.

Methods

We prospectively studied 350 patients who underwent primary and revision total hip replacements and were treated through our ERP form March 2010 to January 2011. The mean age was 68 (range 23-92 years). 130 patients (37%) were considered obese with a BMI of >30. 11 patients (3%) were considered morbidly obese with a BMI >40. They were age & sex-matched with the non-obese patients. Outcomes measured included: Length of stay, wound complications (including surgical site infections), deep vein thrombosis and blood transfusion requirements. Data was collected to 42 days following discharge.

Results

There was no significant difference in the length of stay between the obese (BMI >30) and non-obese (BMI<30) groups; 4.3 days (median 4) and 4.1 days (median 4) respectively. Mean length of stay in the morbidly obese group (BMI≥40) was interestingly, 3.4 days (median 3). 12 patients (9%) in the obese group experienced non-infective wound complications including oozing and haematoma formation compared to 15 patients (7%) of the non-obese group. One confirmed DVT was identified in the morbidly obese group (BMI 41). There were no significant differences in surgical site infections, blood transfusion requirements, or other patient-reported outcome measures at 42 days.

Conclusion

Body mass index (BMI) did not affect the early post-operative outcome of hip replacements in patients enrolled in the ERP. Based on the evidence provided by this study, we would continue to offer hip replacement surgery irrespective of body mass index.

Keynote Lecture 11 : TruMatch Peronalized Solutions by William Bugbee: #1120 September 23rd, 2011, 11:00-11:15

TruMatch Personalized Solutions

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No abstract available

9A : Future technologies: #686 September 22nd, 2011, 14:55-15:45

Assessment of Bone Ingrowth Potential of E-Beam Produced Surface Topographies With a Biomimetic Coating

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Gerjon Hannink - Orthopaedic Research Laboratory - Nijmegen, Netherlands
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INTRODUCTION:

Electron beam melting is a promising technique to produce surface structures for cementless implants. Biomimetic apatite coatings can be used to enhance bone ingrowth. The goal of this study was to evaluate bone ingrowth of an E-beam produced structure with biomimetic coating and compare this to an uncoated structure and a conventionally made implant surface.

METHODS:

Implants: The implants (10x4x4mm) were produced with E-beam technology. (Eurocoating). All E-beam implants had a cubic surface structure (porosity 77%). Two structures were coated (Eurocoating), one with hydroxyapatite (cubicHA) and one with brushite (cubicBR). One was left uncoated. A control specimen with a titanium plasma spray coating (TiPS) was also tested. (Figure 1).

Experimental design: Surgery was performed on 12 goats. A double set of specimens was implanted in the iliac crest. 4 goats were sacrificed 3 weeks after surgery and 8 goats after 15 weeks.

Push out test: The specimens were pushed out the surrounding bone by a Material Testing System (MTS) to define the mechanical strength of the bone-implant interface.

Histology: Maximum bone ingrowth depth was measured with fluorescence microscopy (5 and 10 weeks) and light microscopy at HE stained slices (15 weeks).

RESULTS:

The mechanical strength of the bone-implant interface of the cubic structure and the cubicHA were significantly higher compared to the TiPS control at 15 weeks of implantation. (Figure 2)

The maximum bone ingrowth depth of the cubicHA and cubicBR was significantly greater compared to the uncoated cubic structure at respectively 5 & 15 and 5, 10 & 15 weeks. (Figure 3)

DISCUSSION & CONCLUSIONS:

The results of this study are promising. The E-beam structure performed better than a clinically successful coating. Application of a biomimetic CaP based coating on this E-beam surface provided enhanced bone ingrowth. A large surface area associated with a high porosity (as seen in the cubic structure) is known to allow better bone ingrowth. However a setback of a high porosity is that it takes more time before full integration is established. Application of a biomimetic coating appeared to overcome this by providing improved fixation by bone ingrowth in the early postoperative period.

ACKNOWLEDGEMENTS:

This study is cosponsored by Provincia Autonoma di Trento and Eurocoating SpA, Trento, Italy

Figures

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Figure 6

5B : Spine: #852 September 21st, 2011, 16:20-17:10

The Impact of Low Back Pain and Degeneration on the Coupled Out-of-Plane Rotations in the Lumbar Spine

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Introduction:

Numerous studies have been conducted to investigate the kinematics of the lumbar spine, and while many have documented its intricacies, few have analyzed the complex coupled out-of-plane rotations inherent in the low back. Some studies have suggested a possible relationship between patients having low back pain (LBP) or degenerative conditions in the lumbar region and various degrees of restricted, excessive, or poorly-controlled lumbar motion. Conversely, others in the orthopedic community maintain there has been no distinct correlation found between spinal mobility and clinical symptoms. The objective of this study was to evaluate both the in-plane and coupled out-of-plane rotational magnitudes about all three motion axes in both symptomatic and asymptomatic patients.

Methods:

Ten healthy, 10 LBP, and 10 degenerative patients were CT scanned and evaluated under fluoroscopic surveillance while performing flexion/extension of the lumbar spine. Three-dimensional, patient-specific bone models were created and registered to fluoroscopic images using a 3D-to-2D model fitting algorithm. *In vivo* kinematics were derived at specified increments and the overall in-plane flexion/extension and coupled out-of-plane rotations were analyzed using two techniques. The first method derived the maximal absolute rotational magnitude (MARM) at each level by subtracting the rotational motion in the increment exhibiting the most negative or least amount of rotation from the increment having the greatest amount of rotation. The second method was designed to isolate the path of rotation (POR) of the vertebrae at each level while performing the prescribed flexion/extension activity. By tracking the rotational path of the cephaled vertebrae as it articulated upon the more caudal vertebrae and summing the absolute rotation between each increment about each axis the POR was calculated over the entire flexion/ extension activity.

Results:

Using both the MARM and POR methods, the average overall in-plane rotations between L1 and L5 were not significantly different among any of the groups, although the degenerative group did exhibit less in-plane range-of-motion compared to the healthy and LBP patients. At the L4-L5 level, patients in the healthy and LBP groups achieved 13.1° and 14.4° of rotation, respectively, compared to only 10.7° in the degenerative group. In addition, both of the symptomatic patient groups experienced less rotation during the extension phase of the activity. The coupled out-of-plane motions in both the LBP and degenerative subjects were significantly greater than those observed in healthy subjects ($p=0.0199$ and $p<0.001$, respectively). On average, LBP and degenerative patients achieved 5.5° and 7.1° more out-of plane rotational motion per level, respectively, compared to healthy subjects.

Conclusions:

These findings correlate with previous studies documenting paradoxical motions in the lumbar spine during an overall gross motion and support the idea of pain being a biological response to tissue injury which may result from excessive kinetic energy introduced into the biological system. Identification of these aberrant motion path magnitudes may aid in recognizing possible causes of pain in patients suffering from non-specific low back problems. Increased magnitudes of out-of-plane rotational paths observed in symptomatic patients may also be an indicator for progressive pathologies requiring surgical intervention in the lumbar spine region.

11A : Knee kinematics: #774 September 22nd, 2011, 17:40-18:30

A Novel Technique for Knee Kinematics Tracking Using a-Mode Ultrasound: Simulation and Feasibility Study

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Introduction:

Kinematics tracking is the process by which the motion of the joints is studied. This motion consists of relative rotation and translation of the joint bones. Joint motion analysis is used in diagnosis of joint pathology, as well as studying the normal joint function. Currently, fluoroscopy is used in joint kinematics tracking. We are researching the use of pulse-echo A-mode ultrasound for the bone motion tracking instead of the fluoroscopy to avoid its radiation. In this work we performed feasibility study using simulation, and concluded that it is feasible to perform knee motion tracking with accuracy of 2 mm.

Methods:

The idea of the proposed system is to attach a number of single-element ultrasound transducers to a brace as shown in Figure 1. This brace will have a commercially available optical or electromagnetic tracking system's probe attached to it to track the global motion of the brace. The ultrasound transducers will be responsible for transcutaneously detecting points over the surface of the bone. The bone's echo extracted from each signal at each transducer will be registered in the optical or electromagnetic tracker's coordinate frame to create a set of points acquired over the surface of the bone. These points represent the bone's position at that point of time. A 3D model of the bone is then registered to these points using the iterative closest point method (ICP) to estimate the bone's position. At each tracking step, the 3D model will be at a position close to the new position of the points set, because this process will be repeated at a rate of 100 Hz or more in order to ensure that the change in the bone's position between every two successive tracking steps is small enough to guarantee high tracking accuracy. In this work we simulated the mentioned process using real kinematics data obtained for a patient using fluoroscopy. 3D models of the proximal tibia and distal femur were segmented from CT scans of the patient's knee. These models were then moved using the kinematic data in incremental steps. Simulated points over the surface of the bones (simulating the points on the bone's surface to be acquired using ultrasound) were used to track the bones' simulated motion using another set of the bones 3D models which move only according to the registration with the simulated points. In other words, the tracking models follow the simulated points' motion. Simulation was performed using deep knee bend kinematics data.

Results:

The simulation performed using 24 simulated ultrasound transducers for the femur and 18 for the tibia with the configuration shown in Figure 2. Accumulated tracking error of 0.02, and o.5 mm was obtained for the femur and tibia respectively. The tracking step error for the whole cycle is shown in the Figure 3.

Conclusions:

The tracking accuracy obtained from the simulation proves the feasibility of the proposed method for knee kinematics tracking. This motivated the start of implementation of the system to assess the real accuracy and performance of the proposed method.

Figures

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Figure 6

5A : Knee mechanics: #1095 September 21st, 2011, 16:20-17:10

Principles of 3D Alignment

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No abstract available

Keynote Lecture 7 : Improving Outcome in Knee Replacement: The Role of Technology by Fabio Catani: #1090 September 22nd, 2011, 13:40-13:55

Improving Outcome in Knee Replacement: The Role of Technology

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No abstract available

Keynote Lecture 10 : Alternative Bearings, Meaning and Truth: What Patients Understand by Justin Cob: #459 September 22nd, 2011, 16:25-16:40

Alternative Bearings, Meaning and Truth: What Patients Understand

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Introduction:

Are there really 'conventional' bearings, offering more security and less risk than the 'alternative' bearings that feature in the programme?

Alternative, when used as an adjective has 2 meanings :

1: offering or expressing a choice, as in several alternative plans

2: : different from or functioning outside the usual or conventional:

eg alternative newspaper, alternative rock music, alternative medicine

This paper reviews the elements that make up the bearing couples available today in the developed world, and tests each bearing against these meanings.

Materials:

What are the alternatives?

the materials available today fall into the following broad families:

Metals: Stainless Steel and Cobalt-Chromium Alloy, are the dominant metals available. There is no variation in the Steel, but the characterisation of the Co-Cr does vary. Several manufacturers use different carbide content for the femoral and acetabular components, and different processes. One has been withdrawn from the market, and others may be at risk of this, although it is not the material itself that seems to be the main issue.

Ceramics include alumina and zirconia ceramics. Alumina has been available unchanged for over 40 years, although delta ceramic (a zirconia toughened alumina) has only been available unchanged since 2001, making in available for 10 years.

Polymers: a huge range of polyethylenes are now available, with different individual claims. All claim superior wear resistance, and oxidation resistance. More than 20 unique products are available in the EU, each with a proprietary formula giving individual characteristics.

Coatings and surface treatments: these are now available today from many companies, who either ceramicise the surface of cobalt chrome or titanium with titanium nitride, or use oxinium (a proprietary product from a single company).

Bearing couples: what are the alternatives

Symmetric and Asymmetric bearings are currently offered. Symmetric bearings are available for Ceramic on Ceramic and Metal on Metal bearings only. Asymmetric bearings are available with metals, including metal on poly, and metal on peek. Ceramics can couple with metal or polymers.

Bearing Sizes:

Larger than 32mm should be considered ‘alternative’. The larger metal bearings have seen the start of crevice corrosion at the taper between titanium and Co-Cr, and even between different Co-Cr alloys. This new

class of complication seems to be unique to metal femoral heads.

Bearing-stem compatibility: Larger metal on metal head bearings have brought an entirely new world of complications . The choices of trunion are mainly twofold: the 12/14 tapers which differ significantly between products, and the V40 taper still used by one manufacturer. Neither was designed for use with a larger diameter head.

Conclusions:

The use of the word 'alternative' implies a 'standard' or conventional bearing. Ceramic bearings have changed least, have been immune from the metallosis and crevice corrosion seen with large ball Metal head whether bearing on metal or polyethylene. They also have reassuring long term results. In 2011 they should be considered the standard bearing for the young and active patient. The large diameter metal on highly cross-linked poly bearings should now be considered 'alternative'.

Pleanary session 1 : The future of TKA: #1088 September 21st, 2011, 9:45-10:30

The Future of Knee Arthroplasty: Correcting Patho-Kinematics With the Next Generation of Devices

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The current generation of knee replacements are based upon assumptions from kinematic studies that preceded their designs. These implants were further limited by practical restrictions imposed by affordability, materials and manufacturing, and finally by the methods available to surgeons to prepare the bone and implant them. The early designs of knee seldom distinguished left from right, as the early kinematic work had not appreciated the very different functions of the medial and lateral compartments. Trochlea shape and position within devices was also limited by the published work on the way the knee bends. Surgical insertion has been limited to landmark based registration, and adjustment of the kinematics by soft tissue releases. However accurately such operations were performed, they could not restore normal function, as the kinematics of the joint were quite different from the normal knee.

Recently, we have begun to appreciate three distinct axes of the knee joint: the flexion axis, the extension axis and the trochlea axis. These can be reliably found from 3d imaging, but cannot be immediately established by eye, or by conventional jigs, which must rely on unreliable landmarks acquired in surgery.

The current market leaders in knee joint sales do not reflect these three axes in their joint designs, so the instrumentation used to insert them cannot restore the kinematics of the normal knee. The emerging partial replacements can be designed to take the axes and their resulting kinematics into account. If they are then inserted using robotic assistance, or patient specific guides, they can restore joints to these axes reliably. Knee function following such conservative surgery reflects this improvement in kinematics with higher functional scores and faster top walking speeds than has ever been possible using conventional devices inserted using the conventional landmark based surgical techniques.

14B : Revision and difficult cases - Hip: #484 September 23rd, 2011, 13:50-14:40

Follow-Up of a Custom Made Triflanged Cup for Severe Acetabular Defects

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Abstract

Treatment of Paprosky type 3A and 3B defects in revision surgery of a hip arthroplasty is challenging. In previous cases such acetabular defects were treated with massive structural allograft bone reconstructions using cemented all-polyethylene cups. In our department we started using custom made triflanged cups to restore the articulation of the hip.

The triflanged cups were designed on the basis of CT-image analysis. We are using a new type of implant construction technique with additive technology. This is a production process consisting of ion beam sintering joining metal powder particles layer upon layer on the basis of a 3D model data. The production technique is similar to rapid prototyping manufacturing.

7 Patients have been treated with this new technique. The case studies will be presented with their clinical and radiographic follow-up.

We think that additive technology is a breakthrough in treating this kind of severe acetabular defects.

14A : Patella: #910 September 23rd, 2011, 13:50-14:40

Patellar Kinematics in Different Conditions of Medial Patellofemoral Ligament

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Nicola Lopomo - Istituto Ortopedico Rizzoli - Bologna, Italy
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Introduction

Patellar stability is an important component for a correct kinematic behaviour of the knee that depends on several factors such as joint geometry, muscles strength and soft tissues actions. Patellofemoral (PF) maltracking can results in many joint disorders which can cause pain and mobility alterations.The medial patellofemoral ligament (MPFL) is an important stabilizing structure for the patellofemoral joint. The aim of this study was to analyze patellofemoral kinematics with particular attention to the contribution of MPFL on patella stability.

Methods

Using a navigation system PF kinematics during passive flexion/extension movements with quadriceps loaded at 60N, was recorded on 6 cadavers in three different anatomical conditions: intact knee, MPFL cut and MPFL reconstructed with graft. Test on patella was conducted without lateral force and with applied lateral force (25N). Tilt and lateral shift was evaluated in both cases at 0°. 30°, 60°and 90° of flexion.

Results

Test results without applied force showed that there is no statistical difference between intact knee and MPFL cut conditions in all ranges of flexion, both for medio-lateral shift and tilt, which have low values.

In test with applied force a significative increase of patellar lateral translation at 30° (16,8 ±

13,4 mm) and 60° (18,6 ± 6,4 mm) was found. MPFL reconstructed knee behaviour was not statistically different to intact knee both for tilt and medio-lateral shift. Therefore lateral translation was widely reduced with the graft.

Conclusions

Without applied stress intact knees and MPFL cut knees behave in the same way. In applied load conditions MPFL cut knees show wide lateral translation in respect to intact and reconstructed knees. MPFL reconstructed knees are similar to intact knee therefore MPFL restraint is significant only in stress conditions.

This may indicate that the MPFL is a aponeurosis, with an active role under stress, but low role during neutral knee flexion.

Figures

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Figure 5

10A : Navigation: #1007 September 22nd, 2011, 16:40-17:30

Accuracy of Robotic Assisted Femoral Osteochondroplasty for Treatment of Fai

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Anil Ranawat - Hospital for Special Surgery - New York, USA
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INTRODUCTION

Symptomatic hip disorders associated with cam deformities are routinely treated with surgery, during which the deformity is resected in an effort to restore joint range of motion, reduce pain, and protect the joint from further degeneration. This is a technically demanding procedure and the amount of correction is potentially critical to the success of the procedure: under-resection could lead to continued progression of the OA disease process in the joint, while over-resection puts the joint at risk for fracture. This study compares the accuracy of a new robotically assisted technique to a standard open technique.

METHODS

Sixteen identical Sawbones models with a cam type impingement deformity were resected by a single surgeon simulating an open procedure. An ideal final resected shape was the surgical goal in all cases. 8 procedures were performed manually using a free-hand technique and 8 were performed using robotic assistance that created a 3-dimensional haptic volume defined by the desired post-operative morphology. All of 16 sawbones, including uncut one as well, were scanned by Roland LPX-600 Laser scanner with 1mm plane scanning pitch and 0.9 degree of rotary scanning. Post-resection measurements included arc of resection, volume of bone removed and resection depth and were compared to the pre-operative plan.

RESULTS

The desired arc of resection was 117.7° starting at -1.8° and ending at 115.9°. Manual resection resulted in an average arc of resection error of 42.0 ± 8.5° with an average start error of -18.1 ± 5.6° and end error of 23.9 ± 9.9° compared to a robotic arc of resection error of 1.2 ± 0.7° ($p<0.0001$), an average start error of -1.1 ± 0.9° ($p<0.0001$) and end error of -0.1 ± 1.0° ($p<0.0001$). Over-resection occurred with every manual resection with an average volume error of 758.3 ± 477.1mm^3 compared to an average robotic resection volume error of 31.3 ± 220.7mm^3 (4 over- and 4 under-resected; $p<0.01$).

CONCLUSION

Even using an approach that maximizes visualization, robotic assistance proved to be significantly more accurate and less variable than manual techniques. This is critical as the success of the surgical treatment of FAI depends on accurate and precise boney resection. The benefits of this new technique may prove even more valuable with less invasive, arthroscopic treatments that can be even more technically demanding.

13A : Robotics & navigation: #1010 September 23rd, 2011, 11:15-12:05

Haptic Robot Assisted Surgery Substantially Improves Contact Area for Structural Bone Allograft Reconstructions

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INTRODUCTION

Allograft reconstruction after resection of primary bone sarcomas has a non-union rate of approximately 20%.

Achieving a wide surface area of contact between host and allograft bone is one of the most important factors to help reduce the non-union rate. We developed a novel technique of haptic robot-assisted surgery to reconstruct bone defects left after primary bone sarcoma resection with structural allograft.

METHODS

Using a sawbone distal femur joint-sparing hemimetaphyseal resection/reconstruction model, an identical bone defect was created in six sawbone distal femur specimens. A tumor-fellowship trained orthopedic surgeon reconstructed the defect using a simulated sawbone allograft femur. First, a standard, 'all-manual' technique was used to cut and prepare the allograft to best fit the defect. Then, using an identical sawbone copy of the allograft, the novel haptic-robot technique was used to prepare the allograft to best fit the defect. All specimens were scanned via CT. Using a separately validated technique, the surface area of contact between host and allograft was measured for both (1) the all-manual reconstruction and (2) the robot-assisted reconstruction. All contact surface areas were normalized by dividing absolute contact area by the available surface area on the exposed cut surface of host bone.

RESULTS

The mean area of contact between host and allograft bone was 24% (of the available host surface area) for the all-manual group and 76% for the haptic robot-assisted group (p=0.004).

CONCLUSIONS

This is the first report to our knowledge of using haptic robot technology to assist in structural bone allograft reconstruction of defects left after primary bone tumor resection. The findings strongly indicate that this technology has the potential to be of substantial clinical benefit. Further studies are warranted.

FIGURES

Figure 1. Representative coronal CT image of the final host-allograft reconstruction for a manually reconstructed specimen. This figure demonstrates how the manual reconstruction technique fails to achieve substantial contact on all sides of the host-allograft junction.

Figure 2. Representative coronal CT image of the final host-allograft reconstruction for a robotically reconstructed specimen. This figure demonstrates how the robotic reconstruction technique achieves substantial contact on all sides of the host-allograft junction.

Figures

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Figure 2

10A : Navigation: #735 September 22nd, 2011, 16:40-17:30

Bowing of the Femur: A New Reference Plane for Axial Alignment of Total Knee Replacements

*Kristoff Corten - UZ Pellenberg - Leuven, Belgium
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Summary sentence

The bowing of the femur defines a curvature plane to which the proximal and distal femoral anatomic landmarks have a predictable interrelationship. This plane can be a helpful adjunct for computer navigation to define the pre-

operative, non-diseased anatomy of the femur and more particularly the rotational alignment of the femoral component in total knee arthroplasty (TKA).

Background and aims

There is very limited knowledge with regards to the sagittal curvature -or bowing- of the femur. It was our aim (1) to determine the most accurate assessment technique to define the femoral bowing, (2) to define the relationships of the curvature plane relative to proximal and distal anatomic landmarks and (3) to assess the position of femoral components of a TKA relative to the femoral bowing.

Materials and methods

Four independent algorithms were developed and tested on 3D models of 18 cadaveric femora. A sensitivity study showed that a bisector-based method supplied the most stable results. In order to verify if the curvature plane can be used for TKA alignment, the anteversion angle was determined relative to this plane and compared with anteversion angles defined using the coronal plane.

Results

The average curvature of the cadaveric femora was 895.85 mm (SD = 184.53 mm).

The mean anteversion angle calculated along the projected mechanical or anatomical axis in the coronal plane were 8.2+/-5.2° and 7.6+/- 4.8°. These angles calculated along the projected mechanical or anatomical axis in the curvature plane were 8.2+/-5.2° and 5.2+/-4.8° respectively ($p>0.05$).

Assessment of the component placement relative to the mechanical axis showed that in the coronal plane, an average deviation of 1.84° was measured. In the sagital plane, the average deviation from the mechanical axis was 2.01°. The components were placed in 1 to 2° of extension relative to the femoral bowing.

Discussion

A new and stable algorithm was successfully developed to determine the curvature of the femoral shaft. This curvature was comparable to 2 previously reported curvatures.

Our study also demonstrates a predictable interrelationship between the femoral shaft curvature on one side and the rotation of the distal femur on the other side. This finding is of great interest in view of a recent trend amongst knee surgeons to aim at anatomical restoration of the patient's original anatomy. Patient matched cutting blocks as well as patient specific implants are today increasingly considered in daily practice in an attempt to restore the patient's natural anatomy and biomechanics. Computational methods to reverse engineer the pre-diseased status of the knee joint regarding its anatomy and orientation are therefore of great importance. The findings from our study suggest that the femoral shaft's curvature is a helpful adjunct to this. Furthermore, abnormal rotational alignment of an axially malaligned component can be assessed accurately with this new reference plane. However, further research on implementing this algorithm and this plane into clinical practice is mandatory.However, further research on implementing this into clinical practice is required.

11B : Implant fixation: #739 September 22nd, 2011, 17:40-18:30

Is There a Place for Conservative Treatment of a Vancouver Type B2 Fracture Around a Cemented Exeter Stem?

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The Exeter stem is a polished cemented stem that has been associated with an excellent survivorship. However, this wedge shaped stem has also been associated with a relative higher risk for a peri-periprosthetic fracture due to the wedge-shaped configuration that can lead to a Vancouver type B2 fracture when the stem is being driven downwards inside the femoral canal by a traumatic blast. Traditionally, these fractures should be treated with a revision stem because the stem has become loosened in the fractured cement mantle. We present a case series of 5 cases where our treatment algorithm was to first let the non-displaced fracture to consolidate by 6 weeks of limited weight bearing as tolerated in order to conduct a second stage in-cement revision. This would simplify the revision procedure dramatically. However, all patients are currently pain free and do not require revision surgery although they are being monitored very closely.

We conclude that non-displaced Vancouver type B2 fractures can be approached by a 2 stage treatment algorithm where the initial step is to let the fracture consolidate with limited weight bearing.

The Relationship of Joint Line and Flexion/Extension Axes of the Knee to the Mechanical Axis in the Coronal Planes

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INTRODUCTION

Recent studies indicated that the knee has a single flexion/extension axis but debated the location of this axis. The relationship of the flexion/extension axis in the coronal plane to the mechanical axis has received little attention. The purpose of this study was to investigate the relationship of the various axes and references with respect to the mechanical axis in the coronal plane

MATERIALS AND METHODS

Subjects were prospectively scanned into a Virtual Bone Database (Stryker Orthopaedics, Mahwah, NJ). Database is a collection of body CT scans from subjects collected globally. Only CT Scans that met the following qualifications were accepted: ≤1 mm voxels and had slice thickness that was equal to the spacing between the slices (≤ 1.0mm),

For each CT Scan, a frontal plane was created through the 2 most posterior points of the medial/lateral condyles and the most posterior point of the trochanter. Then, a transverse plane was created perpendicular to the frontal plane and bisects the 2 most distal points on the medial/lateral condyles. Finally, a saggital plane was created that was perpendicular to the frontal and transversal planes.

The following axes were identified: Mechanical Axis of the Femur (MAF) (line between the center of the femoral head and the center of the knee sulcus); Transepicondylar Axis Posterior Cylindrical Axis (PCA) (line between the Medial/Lateral Condylar Circle – best fit circle to three points identified on surface).

Measurements made: Angle of MAF and the Joint-Line (Femoral Joint Angle), Angle of the MAF and the Transepicondylar Axis (Femoral TE Angle), and Angle of the MAF and the Posterior Cylindrical Axis (Femoral PC angle). Angles measuring 90° were neutral or perpendicular to the MAF. Angles measured <90° were valgus and >90° were varus.

RESULTS

CT Scans from 519 knees were studied. The mean femoral joint angle was 86.1°±2.0°(Range:80.2°-92.2°). The mean TE angle was 88.8°±2.5°(Range:81.7°-98.4°). The mean Femoral PC angle was 87.9°±2.2°(Range: 81.8°-94.0°). The average deviations from a neutral resection were 3.8°, 1.2° and 2.1° for the Femoral Joint Angle, Femoral TE Angle respectively. The mean Femoral Joint angle had the lowest variability, while the mean Femoral TE angle showed the largest.

CONCLUSION

On average, the transepicondylar axis and the posterior cylindrical axis were approximately perpendicular to the mechanical axis in the coronal plane. Although surgeons do not align components in the coronal plane specifically to either axis, this data suggests that the average value is within the accepted ±3° range reported. The PCA values are closer to the values of the femoral joint line when compared to the TEA. The PCA may be a more reproducible landmark as it may be determined by either preoperative imaging or intraoperatively from instrumentation that references the distal/posterior surfaces. Further research is warranted.

Figures

Bicompartmental Knee Arthroplasty May Restore Normal Knee Kinematics

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Introduction:

It is well known that total knee arthroplasty (TKA) does not preserve normal knee kinematics. This outcome has been attributed to alteration of soft-tissue balance and differences between the geometry of the implant design and the normal articular surfaces. Bicompartmental knee arthroplasty (BKA) has been developed to replace the medial and anterior compartments, while preserving the lateral compartment, the anterior cruciate ligament (ACL), and the posterior cruciate ligament (PCL). In a previous study, we reported that unicompartmental knee arthroplasty did not significantly change knee kinematics and attributed that finding to a combination of preservation of soft-tissue balance and minimal alteration of joint articular geometry (Patil, JBJS, 2007). In the present study, we analyzed the effect of replacing trochlear surface in addition to the medial compartment by implanting cadaver knees with a bicompartmental arthroplasty design. Our hypothesis was that kinematics after BCKA will more closely replicate normal kinematics than kinematics after TKA.

Methods:

Eight human cadaveric knees underwent kinematic analysis with a surgical navigation system. Each knee was evaluated in its normal intact state, then after BKA with the Deuce design (Smith & Nephew, Memphis, TN), then after ACL sacrifice, and finally after implanting a PCL-retaining TKA (Legion, Smith & Nephew). Knees were tested on the Oxford knee rig, which simulates a quadriceps-driven dynamic deep knee bend. Tibiofemoral rollback and rotation and patellofemoral shift and tilt were recorded for each condition and compared using repeated measures ANOVA for significance.

Results:

Statistically significant differences were noted in femoral rollback between TKA and Intact conditions but not between Intact and BKA or between Intact and BKA without ACL. Statistically significant differences were noted in tibiofemoral rotation between TKA and Intact conditions but not between Intact and BKA or between Intact and BKA without ACL. No significant differences in patellar lateral shift or lateral tilt were found among the four conditions tested.

Discussion & Conclusion:

BKA prostheses that preserve the ACL and PCL allow for more normal knee kinematics than does conventional TKA. Our results supported our primary hypothesis that a bicompartmental approach would not significantly alter knee kinematics. These results also imply that replacement of the medial compartment and trochlear surface are not major factors contributing to altered knee function. The results that we observed may not necessarily apply to other BKA designs and should therefore not be extrapolated beyond the prosthesis designs in this study. Additionally, the current study was designed to only evaluate kinematics, and we can not make conclusions regarding implant wear, fixation, durability, ideal patient selection, and reproducibility of successful clinical outcomes. Lastly, the current study was undertaken using relatively normal cadaveric knees whereas in vivo arthroplasty is typically reserved for arthritic knees that are often affected by contracture and/or deformity. We therefore believe that clinical studies with well-defined measures of success need to be conducted before far-reaching conclusions can be drawn regarding the utility of these implants in clinical practice.

12A : Knee Mechanics: #1073 September 23rd, 2011, 8:30-9:35

Knee Forces During ADL and Sports Activities in TKA Patients

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Knee mechanics - Knee forces during ADL and sports activities in TKA patients

Darryl D'Lima, MD, PhD

Background:

Tibiofemoral forces are important in the design and clinical outcomes of TKA. Knee forces and kinematics have been estimated using computer models or traditionally have been measured under laboratory conditions. Although this approach is useful for quantitative measurements and experimental studies, the extrapolation of results to clinical conditions may not always be valid. We therefore developed a tibial tray combining force transducers and

a telemetry system to directly measure tibiofemoral compressive forces in vivo.

Methods:

Tibial forces were measured for activities of daily living, athletic and recreational activities, and with orthotics and braces, for 4 years postoperatively. Additional measurements included video motion analysis, EMG, fluoroscopic kinematic analysis, and ground reaction force measurement. A third-generation system was developed for continuous monitoring of knee forces and kinematics and for classifying and identifying unsupervised activities outside the laboratory using a wearable data acquisition hardware.

Results:

Peak forces measured for the following activities were: walking (2.6±0.2xBW); jogging (4.2±0.2)xBW; stationary bicycling (1.3±0.15)xBW; golfing (4.4±0.1)xBW; tennis (4.3±0.4)xBW; skiing (4.3±0.1)xBW; hiking(3.2±0.3)xBW; StairMaster exercise (3.3±0.3)xBW; Elliptical machine exercise (2.3±0.2)xBW; leg press machine (2.8±0.1)xBW; knee extension machine (1.5±0.03)xBW, rowing machine (0.9±0.1)xBW.

Conclusions:

In vivo measured knee forces can be used to enhance existing in vitro models and wear simulators and to improve prosthetic designs and biomaterials as well as guide physicians in their recommendations to patients of "safe" activities following TKA.

15A : Alternative treatments: #627 September 23rd, 2011, 14:50-15:40

Vibroarthrography as a Potential Non-Invasive Diagnostic Tool: Application to Articular Cartilage Condition Assessment.

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Anterior knee pain is one of the most frequently reported musculoskeletal complaints in all age groups. However, patient's complaints are often nonspecific, leading to difficulty in properly diagnosising the condition. One of the causes of pain is the degeneration of the articular cartilage. As the cartilage deteriorates, its ability to distribute the joint reaction forces decreases and the stresses may exceed the pain threshold. Unfortunately, the assessment of the cartilage condition is often limited to a detailed interview with the patient, careful physical examination and x-ray imaging. The X-ray screening may reveal bone degeneration, but does not carry sufficient information of the soft tissues' conditions. More advanced imaging tools such as MRI or CT are available, but these are expensive, time consuming and are only suitable for detection of advanced arthritis. Arthroscopic surgery is often the only reliable option, however due to its semi-invasive nature, it cannot be considered as a practical diagnostic tool. However, as the articular cartilage degenerates, the surfaces become rougher, they produce higher vibrations than smooth surfaces due to higher friction during the interaction. Therefore, it was proposed to detect vibrations non-invasively using accelerometers, and evaluate the signals for their potential diagnostic applications.

Vibration data was collected for 75 subjects; 23 healthy and 52 subjects suffering from knee arthritis. The study was approved by the IRB and an Informed Consent was obtained prior to data collection. Five accelerometers were attached to skin around the knee joint (at the patella, medial and lateral femoral condyles, tibial tuberosity and medial tibial plateau). Each subject performed 5 activities; (1) flexion-extension, (2) deep knee bend, (3) chair rising, (4) stair climbing and (5) stair descent. The vibration and motion components of the signals were separated by a high pass filter. Next, 33 parameters of the signals were calculated and evaluated for their discrimination effectiveness (Figure 1). Finally the pattern recognition method based on Baysian classification theorem was used for classify each signal to either healthy or arthritic group, assuming equal prior probabilities.

The variance and mean of the vibration signals were significantly higher in the arthritic group ($p=2.8e-7$ and $p=3.7e-14$, respectively), which confirms the general hypothesis that the vibration magnitudes increase as the

cartilage degenerates. Other signal features providing good discrimination included the 99th quantile, the integral of the vibration signal envelope, and the product of the signal envelope and the activity duration. The pattern classification yielded excellent results with the success rate of up to 92.2% using only 2 features, up to 94.8% using 3 (Figure 2), and 96.1% using 4 features.

The current study proved that the vibrations can be studied non-invasively using a low-cost technology. The results confirmed the hypothesis that the degeneration of the cartilage increases the vibration of the articulating bones. The classification rate obtained in the study is very encouraging, providing over 96% accuracy. The presented technology has certainly a potential of being used as an additional screening methodology enhancing the assessment of the articular cartilage condition.

2A : CAOS session: #823 September 21st, 2011, 11:15-12:05

Automatic Real-Time Reconstruction of Patient-Specific 3D Knee Model Using Ultrasound RF Data

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Introduction

In this work, we present the first real-time fully automatic system for reconstruction of patient-specific 3D knee bones models using ultrasound raw RF data. The system was experimented on two cadaveric knees, and reconstruction accuracy of 2 mm was achieved.

Methods

To use the highest available contrast and spatial resolution in the ultrasound data, the raw RF signals were used directly to automatically extract the bone contours from the ultrasound scans. Figure 1 shows a sample ultrasound B-mode image for cadaver's distal femur, showing some of the scan lines raw RF signals as well as the final extracted contour using our method.

An ultrasound machine (SonixRP, Ultrasonix Inc) was used to scan the knee joint and the RF data of the scans are acquired by custom-built (using Visual C++) software running on the ultrasound machine. An optical tracker (Polaris Spectra, Northern Digital Inc) was attached to the ultrasound probe to track its motion while being used in scanning.

The scanning of the knee was performed at two flexion angles (full extension, and deep knee bend). At each position, the knee was fixed in order to collect scans that represent a partial surface of the bone (which will be later mutually registered to represent the whole bone's surface). Figure 4 shows fluoroscopy images of a patient's knee, showing the different articulating surfaces of the knee bones visible to the ultrasound at different flexion angles. Figure 5 shows a dissected cadaver's knee showing the articulating surfaces visible to ultrasound at 90 degrees flexion.

The custom-built software collects the RF data synchronized with the probe tracking data for each ultrasound frame. Each frame of the RF data is then processed to extract the bone contour. The bone contours are automatically extracted from the RF data frame with frame rate of 25 frames per second. Figure 2 shows a flowchart for the contour extraction process.

The extracted bone contours were then used by the our software, along with the ultrasound probe's tracking data, to reconstruct point clouds representing the bones' surfaces. These point clouds were then aligned to the mean model of the bone's atlas using ICP and integrated together to form 3D point cloud of the bone's surface. A 3D model of the bone is then reconstructed by morphing the mean model to match the point cloud. Figure 3 shows a flowchart for the point cloud and 3D model reconstruction process.

Results

The developed system was tested on two cadavers' knees. The cadavers' knees were CT-scanned and manually segmented. The reconstructed models using ultrasound were then compared to the segmented models. An average error of 2 mm was achieved. Figure 6 shows sample ultrasound RF signals, and their processed version and the extracted bone echoes. Figure 7 shows sample ultrasound frames and the extracted bone contours from them. Figure 8 shows the reconstructed point clouds and 3D models for two distal femurs and a proximal tibia.

Figures

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Figure 2

11B : Implant fixation: #851 September 22nd, 2011, 17:40-18:30

Impact of Implant Size on the Cement Mantle Thickness and Cement-Filling Index in Hip Resurfacing.

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INTRODUCTION

Thermal necrosis of the femoral head, due to heat generation during cement polymerization, is a concern in hip resurfacing. Bone necrosis could cause fractures and/or implant loosening. Some authors[1] found an inverse relationship between the size of the femoral component and the risk of revision after hip resurfacing. We postulate that smaller implants contain proportionally more cement than larger ones and that this could explain the effect of implant size on revision rate. As such, we investigated the relation between implant size and both, the average cement mantle thickness and the cement-filling index (fraction of cement volume and total volume within the implant).

MATERIALS AND METHODS

Nineteen human femoral heads, collected during total hip arthroplasty, were machined for hip resurfacing with original ReCap (Biomet) instruments. The head sizes were chosen so we could implant two resurfacing heads for each even size between 40 and 56 mm, and one for size 58 mm. Each reamed head was provided with a number of anchoring holes proportional to the head size and was kept at 37°C. After pressure-lavage with water at 20°C, polymeric replicas of the original Recap implants were cemented according to a strict protocol. The exact amount of Refobacin Bone Cement LV (Biomet) needed to fill half the volume of the implant was pored into the resurfacing head and 2.5 minutes after starting cement mixing, the implant was manually impacted on the reamed femoral head.

Specimens were scanned with computer tomography from the distal border of the resurfacing head to the top of the dome and CT-images were analyzed with an adapted version of validated segmentation software[2]. Based on gray values we identified four different elements: the polymeric stem and the outer shell of the implant, the cement-free cancellous bone and the cement mantle. Both, the average cement mantle thickness and the cement-filling index were calculated as described previously[3].

RESULTS

The average cement mantle thickness was 2.63 mm (SD: 0.86; 1.65-4.60), the average cement-filling index was 36.65% (SD: 10.81; 21.52-57.60). Cement mantle thickness was poorly correlated with implant size (Pearson's correlation coefficient: -0.12; p=0.628; fig. 1), whereas the cement-filling index had a moderate to good correlation (Pearson's correlation coefficient: -0.51; p=0.026 ; fig. 2)

CONCLUSION

Our results show that the cement mantle thickness is not related to implant size, but that smaller femoral resurfacing heads are easier to fill-up with cement than larger once. As such, we expect more thermal bone necrosis associated to the higher cement-filling index of smaller implants. This could explain their higher early revision rate.

Figure 1: Cement thickness versus implant size of the femoral component.

Figure 2: Cement-filling index versus implant size of the femoral component.

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Figures

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Figure 3 HYPERLINK "http://app.istaonline.org/figures/1612.jpg" \t "_blank"
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Figure 4

6B : Survival / Outcome: #1121 September 22nd, 2011, 8:30-9:35

Clinical Outcome of Hip Resurfacings Depends on Design

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Surface arthroplasty or resurfacing represents a significant development in the evolution of hip replacement. A hip resurfacing arthroplasty (HRA) is a bone conserving alternative to total hip arthroplasty (THA) that restores normal joint biomechanics and load transfer and ensures joint stability. Metal-on-metal (MoM) bearings have been preferred for these large diameter articulations because of their lower volumetric wear and smaller particulate debris compared to metal-on-poly-ethylene bearings. Of the many engineering factors which have contributed to the success of the MoM bearing, the metallurgy, diametral clearance, sphericity and surface finish were thought to be most important. More recently, adverse reactions to metal particles and ions generated by wear and corrosion of the metal surfaces have focused the attention on the importance of coverage angle and cup positioning. Currently, the scientific consensus is that cup coverage angle, diametral clearance and metallurgy have their importance in that order. Precise understanding of manufacturing variables is imperative in obtaining clinical consistency and safety in the patient. It is important to examine femoral fixation, bone remodeling, and wear of MoM implants. For the second and third generation MoM HRA various designs and biomaterials have been used. We have conducted a randomised, controlled trial comparing 9 different hip resurfacing prostheses. Clinical and radiographic outcome and whole blood, serum and urine metal ion levels are evaluated at 6 months, 1 year and 2 years in 180 patients with 9 different HRA designs and the differences are analyzed. Besides, the design quality of the 9 different metal-on-metal prostheses and their accessory instruments have been judged during the operation. The Durom with its Metasul history may claim a metallurgic advantage, and in combination with the highest coverage angle of all cups, it may be the best wear couple, as suggested by low ion measurements. However, as discussed above, an optimal bearing alone is not sufficient to achieve a successful hip resurfacing.

Plenary session 3 : The future of TKA: #1122 September 23rd, 2011, 9:45-10:30

Why I Choose for Surface Replacement in Young THA Patients: Results and Outcome of Revisions

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The surgical treatment of young adults with end-stage hip disease has been a challenge. Inferior THA survival in the young, perceived advantages of hip resurfacing versus THA and advancements in tribology, led to the introduction of 3rd generation Metal-on-Metal-Hip-Resurfacing-Arthroplasty (MoMHRA). To-date, thousands of such prostheses have been implanted worldwide in younger patients, yet little is known regarding long-term outcome. The only studies reporting greater than 10 year outcome come from designer centres with survivorship varying between 88.5 – 96% at 12 years. Arthroplasty Registries (AR) have reported less favourable survivorships with female gender and size having a negative effect on survival. In our independent hip resurfacing centre in Ghent, Belgium, a single surgeon has implanted more than 3500 HRA over more than 12 years. A cohort of 149 patients who received a Birmingham Hip Resurfacing (BHR) at a mean age of 50 years at surgery have now reached a minimum 10 years follow-up. The overall 12-year survival in these young adults is 93.1% (95% CI: 88.3 -98.0), 99% in males and 87.3% in females. These survivorship data are superior to registry reported figures of THA amongst young patients and correspond well with previous reports from designer centres. The long-term survivorship and clinical outcome of the BHR are excellent in men, uninfluenced by preoperative diagnosis or age. However, survivorship in women is inferior and usually related to increased wear and reactions to metal debris.

Malpositioning of components with associated wear-induced soft tissue fluid collections is the most frequent

factor leading to failure of a HRA. In our experience, mid-term outcome following revision is good and complication and re-revision rates can be low. Surgical experience, early intervention in cases of mal-positioned implants, clinical use of ion levels, implantation of larger ceramic-on-ceramic THA femoral heads and patient education are factors in improving outcome and reducing complication and re-revisions following HRA revision.

7B : Shoulder: #1081 September 22nd, 2011, 11:15-12:05

Three-Dimensional Glenohumeral Relationship of Different Surgical Glenoid Planes: A Three-Dimensional CT-Scan Study.

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Three-dimensional Glenohumeral Relationship of Different Surgical Glenoid Planes: a Three-dimensional CT-scan Study

By Prof. Dr. Lieven De Wilde

Abstract:

Background: There is no consensus on which glenoid plane should be used in total shoulder arthroplasty. Nevertheless, anatomical reconstruction of this plane is imperative for the success of a total shoulder arthroplasty.

Methods:

Three-dimensional reconstruction CT-scans were performed on 152 healthy shoulders. Four different glenoid planes, each determined by three surgical accessible bony reference points, are determined. The first two are triangular planes, defined by the most anterior and posterior point of the glenoid and respectively the most inferior point for the Saller's Inferior plane and the most superior point for the Saller's Superior plane. The third plane is formed by the best fitting circle of the superior tubercle and the most anterior and posterior point at the distal third of the glenoid (Circular Max). The fourth plane is formed by the best fitting circle of three points at the rim of the inferior quadrants of the glenoid (Circular Inferior). We hypothesized that the plane with normally distributed parameters, narrowest variability and best reproducibility would be the most suitable surgical glenoid plane.

Results:

No difference in position of the mean humeral center of rotation is found between the Circular Max and Circular Inferior plane (X=91.71degrees/X=91.66degrees p=0.907 and Y=90.83degrees /Y=91.7degrees p=0.054 respectively), while clear deviations are found for the Saller's Inferior and Saller's Superior plane ($p \leq 0.001$). The Circular Inferior plane has the lowest variability to the coronal scapular plane ($p<0.001$).

Conclusion: This study provides arguments to use the Circular Inferior glenoid plane as preferred surgical plane of the glenoid.

Key words: Anthropometric; Glenoid center; Humeral center of rotation; 3D CT-scan; Gleno-humeral relationship; Glenoid plane; shoulder arthroplasty.

*Level of evidence: Level II, Basic Science Study, Anatomical Survey***.**

7B : Shoulder: #1104 September 22nd, 2011, 11:15-12:05

Stemless Designs in Shoulder Arthroplasty

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Humeral implant design in shoulder arthroplasty has evolved over the years. The third generation shoulder prostheses have an anatomic humeral stem that replicates the 3-dimensional parameters of the proximal humerus. The overall complication rate has decreased as a result of these changes in implant design. In contrast, the rate of periprosthetic humeral fractures has increased. To avoid stem-related complications while retaining the advantages of the third generation of shoulder implants, the stemless total evolutive shoulder system has been developed. The indications, the surgical technique, and the complications of this humeral implant in shoulder arthroplasty will be described.

3A : Navigation: #935 September 21st, 2011, 13:50-14:40

Kinematic Alignment Versus Standard Mechanical Alignment in Cadaveric Knee Specimen

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INTRODUCTION

While standard instrumentation tries to reproduce mechanical axes based on mechanical alignment guides, a new "shape matching" system derives its plan from kinematic measurements using pre-operative MRIs. The current study aimed to compare the resultant alignment in a matched pair cadaveric study between the Shape Match and a standard mechanical system.

METHODS

A prospective series of Twelve (12) eviscerated torso's were acquired for a total of twenty four (24) limb specimens that included intact pelvises, femoral heads, knees, and ankles. The

cadavers received MRI-scans, which were used to manufacture the Shape Match cutting guides. Additionally all specimen received "pre-operative" CT-scans to determine leg axes.Two (2)

investigating surgeons performed total knee arthroplasties on randomly chosen sides by following the surgical technique using conventional instruments. On the contralateral sides, implantation of the same prosthesis was done using the Kinematic Shape Match Cutting Guides. A navigation system was used to check for leg alignement. Implant alignement was determined using post-operative CT-scans. For statistical analysis SPSS was used.

RESULTS

In measurements using the navigation system, the overall alignment of the leg showed no significant differences between the two tested systems. This was also found in the CT-Measurements. In the Shape Match group the difference between the planned and

the final implantation regarding overall limb alignment ranged between -0,5° (valgus) and 6° varus (p=0,518; CI -1,97°/1,05°). The leg alignement in the conventional group ranged between -2,5° and 13° varus (p=0,176; CI -4,93°/1,02).

DISCUSSION AND CONCLUSION

As expected, the two compared system employ different alignment strategies, which reflected in variations of the combinations of the three-dimensional component position on the femur and the tibia. These different strategies result in overall leg alignment that compares well between the two different methods, with fewer outliers in the Shape Match group.

9A : Future technologies: #536 September 22nd, 2011, 14:55-15:45

Paprosky Type IIIb Pelvic Defect Reconstruction by Patient-Specific Technology

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Introduction

As population grows older, and patients receive primary joint replacements at younger age, more and more patients receive a total hip prosthesis nowadays. Ten-year failure rates of revision hip replacements are estimated at 25.6%. The acetabular component is involved in over 58% of those failures. From the second revision on, the pelvic bone stock is significantly reduced and any standard device proves inadequate in the long term [Villanueva et al. 2008]. To deal with these challenges, a custom approach could prove valuable [Deboer et al. 2007].

Materials and methods

A new and innovative CT-based methodology allows creating a biomechanically justified and defect-filling personalized implant for acetabular revision surgery [Figure 1].

Bone defects are filled with patient-specific porous structures, while thin porous layers at the implant-bone interface facilitate long-term fixation. Pre-operative planning of screw positions and lengths according to patient-specific bone quality allow for optimal fixation and accurate transfer to surgery using jigs.

Implant cup orientation is anatomically analyzed for required inclination and anteversion angles. The implant is patient-specifically analyzed for mechanical integrity and interaction with the bone based upon fully individualized muscle modeling and finite element simulation.

Results

Ten clinical severe pelvic bone defects, classified Parosky IIIb, have benefited from this methodology so far. Implant outline, thickness, fixation and cup orientation was adapted to the anatomical situation. Stress shielding of the bone was eliminated by taking into account personalized muscle anatomy, bone quality and patient weight while evaluating the design performance. All implants were applied smoothly intra-operatively because of personalized case documentation provided and jig technology for accurate pre-drilling of screw holes. Postoperative imaging showed excellent results. Short term follow-up indicates good outcome for the patients treated, restoring mobility and functionality, and showing solid anchorage to the bone.

Conclusion

Complex acetabular bone defects can be treated adequately and efficiently, using a personalized solution which addresses both patient's and surgeon's needs.

Figures

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Figure 1

4B : Hip resurfacing: #740 September 21st, 2011, 14:50-15:40

Impact of Cementing Technique on the Cement Mantle in Hip Resurfacing.

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Impact of Cementing Technique on the Cement Mantle in Hip Resurfacing.

An In Vitro CT-Scan Analysis

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INTRODUCTION:

The cement quantity and distribution within femoral hip resurfacings are important for implant survival. Too much cement could cause thermal bone necrosis during polymerisation. Insufficient cement and cement-implant interfacial gaps might favour mechanical loosening. Exposed cancellous bone within the implant, might facilitate debris-induced osteolysis. This study assessed the impact of the cementing technique on the cement mantle quality in hip resurfacing.

METHODS:

We prepared 60 bovine condyles for a 46 mm ReCap (Biomet) resurfacing and cemented polymeric replicas of the original implant using five different techniques: low-viscosity cement filling half the implant with and without suction (LVF+/-S), medium-viscosity cement spread inside the implant (MVF), medium-viscosity cement packed on bone (Packing) and a combination of both last techniques (Comb.). Half the specimens had six anchoring holes. Specimens were CT-scanned and analyzed with validated segmentation software [1].

We assessed, with an analysis of covariance, the effect of the cementing technique (fixed factor), the presence of

anchoring holes (fixed factor) and the bone density (covariate) on the cement mantle quality.

RESULTS:

In contrast to both fixed factors, bone density had no significant effect on the cement mantle quality. Both LVF techniques, created a heterogeneous cement mantle with large quantities of cement especially in the dome of the implant (Fig.1 & 2). Large areas of uncovered cancellous bone were found at the base (Fig. 2). Suction had no major effect. The MVF technique allowed a better control of the cement quantity (Fig. 1) but cement mantle heterogeneity and exposed cancellous bone distally persisted. With the combined technique, large cement quantities were found within the implant (Fig. 1), the cement mantle remained heterogeneous but the amount of uncovered bone distally decreased. Cement packing controlled the cement quantity and distribution within the implant best (Fig. 1 & 2). However, interfacial gaps [2] covered 10% of the proximal cement-implant interface and exposed bone distally could not be prevented (Fig. 2).

When large quantities of cement were available (LVF+/-S and Comb.), anchoring holes allowed even more cement to be pressurised into the cancellous bone (Fig. 1).

DISCUSSION & CONCLUSIONS:

During implantation with a filling technique (LVF+/-S, MVF & Comb.), cement inside the implant was scraped along the reamed head and forced to accumulate proximally. This overfilled the dome and left bone exposed at the base. During cement packing, the air-filled implant scraped excessive cement from the reamed head. This resulted in the thinnest, most homogeneous cement mantle and avoided overfilling. However, air got trapped below the implant and formed interfacial gaps. Anchoring holes in cancellous bone of the reamed head should be avoided to prevent overfilling the reamed head with cement.

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Fig. 1: Relation between cementing technique and % of the head filled-up with cement. Means and standard errors adjusted assuming all specimens had a density of â��445.56 HU.

Fig. 2: CT reconstruction of a resurfacing. (A) LVF+S & holes (heterogeneous and overfilled). (B) Cement packing & holes (homogenous, less filled but with interfacial gaps [arrowheads]).

Figures

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Figure 4

4B : Hip resurfacing: #959 September 21st, 2011, 14:50-15:40

Impact Loads and Stresses in Hip Resurfacing

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INTRODUCTION

Resurfacing prostheses are implanted by impaction onto the prepared femoral head. Ceramic resurfacings can be proposed as an alternative to metal implants, combining bone conservation with mitigation of sensitivity reaction risks. With low wall-thickness required for bone conservation, their strength must be verified. This study aimed to assess a ceramic resurfacing prosthesis' strength under surgical loads using a computational model, tuned and verified with physical tests.

METHODS

1) Tests were conducted to obtain baseline impact data (Fig1 left). Ø58mm DeltaSurf prostheses (Finsbury Development Ltd., UK), made from BIOLOX Delta (CeramTec AG, Germany) ceramic were cemented onto 40pcf polyurethane foam stubs (Sawbone AG, Sweden) attached to a load cell (Instron 8874, Instron Corp.,

USA). Ten repeatable $2ms^{-1}$ slide hammer impacts were applied with a 745g mass. The reaction force at the bone stub base was recorded, and the cumulative impulse was calculated by integrating reaction force over time.

2) A half-plane symmetry model was developed using LS-DYNA (ANSYS Inc., USA) explicit dynamic FE analysis software (Fig1, right). The bone stub was constrained, and the mallet was given an initial velocity of 2.0m/s. Outputs were the impact reaction force at the bone stub base, the impact duration and the peak tensile prosthesis stress.

First, the model was solved representing the experimental setup, to fit damping parameters. Then the damped model was used to predict the peak prosthesis stresses under more clinically representative loads from a 990g mallet. The smallest (Ø40mm) and largest (Ø58mm) prosthesis heads in the size range were analysed, with two impact directions: along the prosthesis axis, and with the impactor inclined at 10°.

RESULTS AND DISCUSSION

The experimental tests gave a mean peak impact force of 4.70kN (S.D.0.11kN), an impact duration of 1.1ms (S.D. 0.06ms) and a total impulse of 2.88Ns (S.D. 0.017Ns). The damped basic FE model gave a peak impact force of 7.0kN, an impact duration of 0.70ms and a total impulse of 2.88Ns. The model overestimated the measured peak impact force by 49% and underestimated the impact duration by 36% (Fig.2), but was in close agreement with the measured cumulative impulse (Fig3).

The peak force and impulse results were consistent with surgical and cadaveric test measurements [1,2]. Comparison with a similar computational analysis [3] suggest that this study's stiff polyurethane foam stub represents a worse case than bone, with a similar overall impulse but a higher peak force and lower impact duration. The model therefore represents a conservative case, which is beneficial in pre-clinical analysis.

With the surgical impact model, peak prosthesis stresses of 42.5MPa and 68.7MPa were predicted for the Ø40mm head with axial and inclined impaction respectively. For the Ø58mm head, the peak stresses were 20.0MPa (axial) and 27.9MPa (inclined). Stresses were highest with inclined loading, which stressed the prosthesis stem root. The maximum stress predicted was 6% of the 1150MPa material strength [4], indicating that the prosthesis strength should be sufficient to sustain surgical impaction loads.

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Figures

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Figure 4

Quantification of Vitamin E in UHMWPE

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Introduction

Increased oxidative stability of orthopedic implants can be achieved by adding an antioxidant, such as Vitamin E (VE) to UHMWPE HYPERLINK "" \l "_edn1" [1]. The effect of shelf live and accelaterated aging in combination with shelf live on antioxidative effectiveness of VE needs to be investigated to better understand the long-time behavior of VE-blended UHMWPE in an oxidative environment. Currently, IR techniques provide

detection limits as low as 0.05 %w/w HYPERLINK "" \l "_edn2" [2], also it is known that thermo analytical techniques can push the limit of detection down to 10 ppm HYPERLINK "" \l "_edn3" [3]. The goal of this study was to quantify VE in UHMWPE powder and compression molded UHMWPE with 11 different VE concentrations using FTIR and DSC techniques and to establish respective regression curves.

Methods & Materials

GUR 1050 UHMWPE resin (Ticona, Germany) was blended with VE (DSM, Netherlands) to the following target concentrations (%w/w): 0.01, 0.02, 0.05, 0.1, 0.25, 0.35. Concentrations of 0.001, 0.002, 0.003, 0.004, 0.005 were obtained by mixing of the 0.1 powder with virgin GUR 1050 powder. VE-free GUR 1050 was used as reference. Samples of blended resin were compression molded in a low oxygen environment atmosphere at Zimmer Inc. (Warsaw, IN). Subsequently the blocks were microtomed, creating films with a thickness of 200μm for each concentration. The VE concentration was measured using infrared (IR) spectroscopy (BioRad FT6000). The ratios were calculated by normalizing the integrated ether C-O(R) signal (1232cm^{-1} to 1275cm^{-1}) and the integrated hydroxyl C-O(H) signal (1190cm^{-1} to 1228cm^{-1}) using the twisting CH bond (1980cmâ��1 to 2100cm^{-1}) as reference peak area. Oxidative induction time (OIT) at 200°C was measured according to ASTM D 3895-98 using blended and mixed powder samples.

Results

Infrared spectroscopy: A strong positive linear correlation between the normalized peak areas and the effectively blended VE content was detected for both ether (Figure 1) and hydroxyl ratios.

Figure 1: Normalized ether signal plotted over blended VE sample (928 IR spectra / 7 VE concentrations).

Samples below 0.01 %w/w were not FTIR tested as they fell below the detection limits of 0.0074 and 0.0092 %w/w HYPERLINK "" \l "_edn4" [4] based on ether and hydroxyl ratios.

Oxidative-induction time: A logarithmic correlation between oxidation time and the effectively blended VE content was detected (Figure 2).

Figure 2: OIT over effectively blended VE concentration (36 data points / 12 VE concentrations)

Using OIT, VE concentrations down to 0.001 and 0.002 %w/w VE were quantified with $D_{absolute}$ of below 0.0002 %w/w and $D_{relative}$ of below 20% to the regression (Figure 3).

Figure 3: Relative differences of quantification of VE over blended VE to regression via OIT and IR

Discussion

This study proves detectability of VE concentrations of 0.01 %w/w via calibrated IR absorbance and 0.001 %w/w using a calibrated OIT method at 200°C. Thus, mapping of VE chemical moities within UHMWPE samples below 0.05 %w/w VE by IR and detection of antioxidative stabilization in UHMWPE samples containing less than 0.002 %w/w VE can be achieved. Based on these findings, highly accurate VE measurements for aged, unaged, retrieved and differently processed materials shall be enabled.

References

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HYPERLINK "" \l "_ednref3" [3] H. E. Bair, Polym. Eng. Sci. 13 (1973) 435-439

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Figures

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Figure 6

13B : Hip arthroplasty: #666 September 23rd, 2011, 11:15-12:05

Dislocation Potential in Conventional and Dual Mobility Hip Joint Couples

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Mayur Thakore - Stryker - Mahwah, USA
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Studies have indicated that the shallow Ultra High Molecular Weight Polyethylene (UHMWPE) acetabular socket or the socket with no head center inset can significantly increase the risk of hip joint dislocation. A previous study suggested the rim loading model in UHMWPE socket and metal femoral head can generate an intrinsic dislocating force component pushing head out of socket. Recently there has been renewed interest in dual mobility articulations due to the excellent stability. The outer bearing couple of the dual mobility articulations are comprised of the UHMWPE femoral head and metal acetabular socket while inner bearing is the locked conventional metal-poly construct. The acetabular socket is also featured by an anatomically shaped head inset wall. The purpose of this study was to theoretically compare the intrinsic dislocating force between conventional metal head on UHMWPE socket articulations and the poly head on metal socket articulations used in the dual mobility cup under direct loading.

The 3-D finite element analysis (FEA) models were same as previous study but with different material combinations. Sixty FEA model assemblies were consisted of CoCr or UHMWPE femoral heads and their corresponding 10mm thick generic UHMWPE or CoCr acetabular sockets. There were five different head center insets of 0, 0.5, 1, 1.5 and 2mm for each of six bearing diameters of 22, 28, 32, 36, 40 and 44mm for either sockets. The joint load of 2,446N was applied through the femoral head center as the same fashion as previous study. The dislocating force generated by the joint loading force intrinsically pushed femoral head out of socket. FEA results were verified with two data points of physical testing of actual UHMWPE 28mm ID liners with 0 and 1.5mm head center insets.

The highest dislocating force was 1,269N per 2,446N of rim loading force for the 0mm head center inset in poly cup with 22mm CoCr femoral head or the case of easiest to dislocate. The lowest dislocating force was 17.7N per 2,446N force for the 2mm inset in CoCr socket with 44mm poly head which therefore was the least likely to dislocate. The average dislocating force decreased by 78% from metal head- poly cup couple to poly head - metal cup couple. The dislocating force decreased as the head center inset and head size increased in all material cases.

The study suggests that not only the head center inset and head size but also the bearing material combinations can affect the intrinsic dislocating force component. The dual mobility poly head and metal socket couple generates less intrinsic dislocating force in all comparable conditions for conventional metal head and poly socket couple. During the hip separation and vertical placement of the cup, all variables found in this study may play the important rules to maintain joint stability. The stiffened cup rim reduces the deformation and thus reduces the potential cup wedge effect to generate dislocating force. The result of this study should provide the guidance to improve acetabular cup design for better joint stability

Figures

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Figure 2

Plenary session 2 : Award Session: #1124 September 22nd, 2011, 9:45-10:30

How to Innovate Safely; Conducting Better-Designed Clincial Studies to Prove Efficacy of New Implants and Treatments

*Lars Engebretsen - Norwegian School of Sport Sciences - Oslo, Norway
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This talk will highlight the current situation for evidence based medicine in orthopaedic sports traumatology. By using examples from my own research I will tell you why I became interested in this field. Then we will go through new studies and current status in the fields of cartilage treatment, ligament reconstruction with a specific eye towards non surgical and surgical treatment and the relatively new field of prevention of sports injuries. These slides will highlight our current short comings and suggest improvement. The talk will be summarised with an example of perfect design, implementation and publication in hip surgery and with the rules of randomized controlled studies.

1. Studies should be prospective with a clearly defined hypothesis and one clearly defined primary end point. They should be randomized controlled trials with an adequate randomization procedure and power analysis for the primary end point. Secondary end points should only be used as supportive evidence to the primary hypothesis.

2. Patient inclusion and exclusion criteria should be clearly established and reported. The recruitment rate should be reported, and attempts should be made to account for eligible patients who are not included and those who are lost follow-up.

3. The outcome measure should be validated for use on patients with the injury being researched.

4. Outcome assessment should be made by an independent investigator. The assessment should be in a written form and ideally be completed by the patient without investigator assistance.

5. The timing of the outcome assessment should be clearly stated. Results from various time-points after surgery should not be reported as one outcome. Assessments should be both clinical and functional. The minimum duration of follow-up should be more than twenty-four months.

6. Detailed rehabilitation protocols should be established and reported. Attempts should be made to monitor compliance. The protocols should be applied in a standardized manner to both patient cohorts.

6B : Survival / Outcome: #1123 September 22nd, 2011, 8:30-9:35

Significant Improvements in Clinical Practice Due to the Knee Arthroplasty Registries

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This talk will present the practical use, results and current conclusions from the Norwegian Joint Registry. The following will be highlighted.

Fixation

Patella resurfacing?

Implant selection and mobile bearing

Computer navigation

UKA and PROM in UKA and TKA

Volume of surgery

Tenders

Improvement in survival

International collaboration

Hospital reports

9B : Short stems: #494 September 22nd, 2011, 14:55-15:45

A New Bone Preserving Hip Arthroplasty (BMHR) for Young and Active Patients

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Bone preserving hip arthroplasty devices are appealing for use in young patients because their high-demand activities and extended lifetimes makes the prospect of multiple revisions a reality. Therefore prostheses which ensure a straightforward revision with a low complication rate and good clinical outcome are favourable for young and active patients.

Modern hip resurfacing serves these conditions and shows very good mid-term and now longer term (10 and 13 years) results especially in osteoarthritis. With other diagnoses like avascular necrosis, deformities of the femoral head in m. Perthes or slipped femoral epiphysis (SUFE), or in large bone cysts and erosive arthritis the bone stock of the femoral head gives insufficient support to the femoral component. In these conditions the alternative to a resurfacing procedure had been a stemmed total hip arthroplasty (THA).

The Birmingham Mid Head Resection device (BMHR; Smith&Nephew Orthopaedics) is an alternative to resurfacing and to a stemmed THA. The BMHR device consists of an uncemented short stem made of titanium alloy and a large diameter cobalt-chrome head. The stem does not enter the femoral canal thus facilitating future revisions. The metal-on-metal bearing is the same as in resurfacing. The instrumentation allows switching from a planned BHR to the BMHR. The BMHR uses the unique anatomy of the head neck junction to prepare internally a cone that matches the frustoconical section of the BMHR stem. Thus a cement free press fit can be achieved. This maintains anatomical load transmission and avoids osteopenia of the proximal fenur.

Since 2006 we have performed 662 BMHR implantations. The indications were osteoarthritis in about 70%, dysplasia in 20%, AVN 5,5%, posttraumatic OA in 3%, SUFE and m. Perthes in 1%. Complications occurred in 3,2%. Fractures of the femoral neck occurred in 8 patients, 4 of them caused by technical errors in the beginning, 3 because of higher risk indication. All revisions were performed successfully and the cup was retained. Low grade infections in 2 cases with one stage revision and 3 unstable cups needed to be reinserted. All revisions were successful. One early dislocation was treated by closed reduction, another remained unstable and was treated by THA. In conclusion we continue to use the BMHR to bridge the gap between resurfacing and stemmed THA because the complications we experienced are not inevitable and had become very rare with our growing experience.

9B : Short stems: #416 September 22nd, 2011, 14:55-15:45

Stability of Short Stem Femoral Implants: A Multi-Centered Clinical Report on the First 150 Lateral Flare Stems

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Short Stems: Are They Safe?

Joseph F. Fetto MD

Recent trends in surgical techniques for THR, i.e. MIS and anterior approaches, have spawned an interest in and possible need for shorter femoral prostheses. Although, early clinical investigations with custom short stems have reported very encouraging results, the transition to off-the-shelf (OTS) versions of shorter length prostheses has not met with the same degree of success. Early reports with OTS devices have documented unacceptably high and significant incidences of implant instability, migration, mechanical/aseptic failure, and technical difficulty in achieving reproducible implantation outcomes. They have highlighted the absolute need for a better understanding of the consequences of changes in implant design as well as for improvements in instrumentation and surgeon training.

Two basic questions must be addressed. First, what is the purpose of a stem? And second, can stem length be reduced and if so by how much can this be safely done. What are the effects of stem shortening and are there other design criteria which must take on greater importance in the absence of a stem to protect against implant failure.

To examine these questions a testing rig was constructed which attempts to simulate the in vivo loading

situation of a hip, fig.1. Fresh cadaveric femora were tested with the femora intact and then with femoral components of varying stem length implanted to examine the distribution of stresses within the femur under increasing loads as a function of stem length.

Our studies indicated that a stem is not an absolute requirement in order to achieve a well functioning, stable implant. However in order to reduce the possibility of mechanical failure a reduced stem or stemless implant absolutely must have three important characteristics to its design. First, it must have sufficient medial/lateral dimension to provide stability against subsidence and varus stress; second it must have a flat posterior surface, parallel and in contact with the posterior endosteal surface of the proximal femur with which to maximize A/P stability against flexion/extension forces (As a consequence of this design feature, appropriate anteversion must be achieved in the neck region of the prosthesis and not by rotation of the implant within the proximal metaphyseal cavity of the femur); and third, the implant must also have a cross-sectional geometry that will stabilize against torsional loading about the long axis of the femur.

Therefore, simply reducing the length of an existing implant to accommodate changes in surgical techniques may not be a reasonable or safe design change. Such shortened versions of existing stem designs must be rigorously tested before being released for general use. The required design parameters outlined above have been clinically validated in custom fabricated implants. They have been shown to reduce aseptic loosening and migration of a short stem femoral implant. This report will provide the clinical review of a multi-center experience with the first 150 off-the-shelf “Lateral Flare” short stem implants.

Leg Length Change in Total Hip Arthroplasty With Subtrochanteric Femoral Shortening Osteotomy for Crowe Type IV Developmental Hip Dysplasia

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Takayuki Nishiyama - Kobe University Graduate School of Medicine - Kobe, Japan
Shinya Hayashi - Kobe University Graduate School of Medicine - Kobe, Japan
Noriyuki Kanzaki - Kobe University Graduate School of Medicine - Kobe, Japan
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Background:

Total hip arthroplasty for Crowe type IV developmental dysplasia of the hip is a technically demanding procedure. Restoration of the anatomical hip center frequently requires limb lengthening in excess of 4 cm and increases the risk of neurologic traction injury. However, it can be difficult to predict potential leg length change, especially in total hip arthroplasty for Crowe type IV developmental hip dysplasia. The purpose of the present study was to better define features that might aid in the preoperative prediction of leg length change in THAs with subtrochanteric femoral shortening osteotomy for Crowe type IV developmental dysplasia of the hip.

Patients and Methods:

Primary total hip arthroplasties with subtrochanteric femoral shortening osteotomy were performed in 70 hips for the treatment of Crowe type IV developmental hip dysplasia. The patients were subdivided into two groups with or without iliofemoral osteoarthritis. Leg length change after surgery was measured radiographically by subtracting the amount of resection of the femur from the amount of distraction of the greater trochanter. Preoperative passive hip motion was retrospectively reviewed from medical records and defined as either higher or lower motion groups.

Results:

The preoperative flexion of patients without iliofemoral osteoarthritis was significantly higher than for patients with iliofemoral osteoarthritis. All hips without iliofemoral OA had higher motion. The preoperative flexion in the higher motion group both with and without iliofemoral OA was significantly greater than in the lower group with iliofemoral OA (Figure 1). Leg length change in patients without iliofemoral osteoarthritis was significantly greater than with iliofemoral osteoarthritis (Figure 2), and the higher hip motion group had greater leg length change in THA than the lower motion group. No clinical evidence of postoperative neurologic injury was observed in patients with iliofemoral OA. Postoperative transient calf numbness in the distribution of the sciatic nerve was observed in 2 of 25 hips without iliofemoral OA (8.0%), however, no sensory and motor nerve deficit

was observed.

Discussion:

The authors hypothesized that preoperative hip motion could affect soft tissue contractures, and our findings suggest that the soft tissues surrounding the hip joint with iliofemoral OA should be more contracted than the hip without OA. We also found leg length change in the higher motion group was greater than in the lower motion group. Previous studies reported limb lengthening in excess of 4 cm could increase the risk of nerve palsy. Transient calf numbness in the distribution of the sciatic nerve was observed in 2 hips without iliofemoral OA and their leg length change was not greater than 4 cm. Our findings suggest that hips without iliofemoral OA should be paid attention to protect the nerves from excessive elongation. The current study identifies several features that might help predict leg length change during the preoperative planning of total hip arthroplasty for Crowe type IV developmental hip dysplasia.

Figures

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Figure 2

7B : Shoulder: #1126 September 22nd, 2011, 11:15-12:05

Trabecular Metal Technology in Shoulder Arthroplasty

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Shoulder arthroplasty has experienced exponential growth in the past 10-15 years, largely due to improvements in anatomical design, increased application of technology to address various clinical pathology, and improved access to experienced shoulder surgeons. Glenohumeral arthritis has historically been the most common indication for a shoulder replacement, and glenoid wear has been the main concern with regards to longevity of the prosthesis. Attempts to improve glenoid components involve alterations in peg or keel configuration, as well as the introduction of metal backed constructs. Early experience with metal backed components led to very poor results with often catastrophic loosening and destruction of glenoid bone. Proximal humerus fractures are another common indication for a shoulder arthroplasty, and in these cases, tuberosity fixation and healing are the challenge precluding a consistently successful result. More recently, base plate fixation in the setting of a reverse shoulder arthroplasty has come to the forefront as a significant factor.

Trabecular metal technology has emerged as a compelling method of enabling powerful bone ingrowth to the surfaces of arthroplasty components. Trabecular metal is composed of tantalum. It is used to form a carbon scaffold which has a modulus between that of cancellous and cortical bone, thus has some flexibility when made into an independent construct. Vapor deposition onto arthroplasty surfaces provides a bone ingrowth surface. There is interest in utilizing trabecular metal for glenoid and tuberosity fixation in particular.

Trabecular metal proximal coated stems provide an ingrowth surface for tuberosity fixation in the setting of proximal humerus fractures. Long term results are still pending. Because the metal is much less stiff then other metals, trabecular metal has recently been used along the back of polyethylene glenoids. The original design had a problem with fracture at the base of the pegs. A redesigned component instituting a cruciate design was implemented, and is currently available on a limited release basis with promising early results. The use of trabecular metal on the deep surface of the reverse arthroplasty baseplate and the proximal aspect of the reverse stem has led to successful fixation, allowing cementless fixation of both the humeral and glenoid components.

Learning objectives of this presentation include:

Understand the mechanical characteristics of trabecular metal and its bone ingrowth characteristics.

Familiarize with currently available prosthetics incorporating trabecular metal technology.

Case presentations utilizing trabecular metal coated components.

Plenary session 3 : The future of TKA: #1127 September 23rd, 2011, 9:45-10:30

Cementless Total Hip Arthroplasty in Young Patients

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Cementless arthroplasty has progressed substantially in the recent decades from pressfit implantation to porous-coated and later HA-coated implant fixation as its ultimate current state-of-the-art incarnation. As a consequence ever younger and older patients have received the benefits of hip and other arthroplasty although attention to age-related factors is key to success. Key factors for success, from the implant perspective, are adequate primary stability of the device in the bone supported by design and surface structure variables that together with optimal implant biocompatibility result in durable osseo-integration of the device. The high activity levels of younger patients but similarly the generally inferior muscular condition of elderly patients require special attention for the stability of the hip joint with avoidance of impingement. Also bone quality may be a topic for consideration to avoid problems. Excellent survival rates past twenty years are documented in both literature and registries with quantitative studies confirming the excellent implant stability and bone quality. With an optimal consideration for patient related factors as well as anatomic reconstruction of the arthroplasty, modern cementless arthroplasty provides every patient an outlook on both excellent long term functionality and survival.

Keynote Lecture 6 : Modern design concepts in shoulder arthroplasty by Christian Gerber: #1128 September 22nd, 2011, 11:00-11:15

Modern Design Concepts in Shoulder Arthroplasty

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No abstract available

2A : CAOS session: #450 September 21st, 2011, 11:15-12:05

Pre-Operative Navigation in Performance of TKA: Assessment of Patient-Specific (MyKnee) Cutting Blocks in Performance of TKA

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Introduction:

Multiple techniques exist for performance of Total Knee Arthroplasty (TKA). In April 2010, MyKnee® Patient-Specific Instrumentation (Medacta International, SA, Castel San Pietro, Switzerland) was approved for use in TKA in the United States. The present retrospective study seeks to evaluate early results of this technique. 29 consecutive patients (30 consecutive TKA operations) underwent TKA using the MyKnee cutting-blocks. These results were compared to 30 consecutive patients utilizing Standard TKA method. The findings represent the author's first MyKnee patients, and thus early learning curve for this technique. IRB approval for retrospective research was obtained prior to the evaluation of the data.

Methods:

30 consecutive patients (14 males, 16 females) underwent TKA using the MyKnee technique. Pre-operative long-standing radiographs were taken and compared to 6-week post-operative radiographs. Intraoperative data includes the femoral and tibial resections thickness: Distal Medial femoral, Distal Lateral femoral, Posterior Medial Femoral, Posterior Lateral femoral, Medial Tibia, and Lateral Tibia. These were compared to the Planned vs. Actual resections. Tourniquet time was recorded as a measure of speed of surgery. These were compared to 30 consecutive patients using Conventional TKA technique. Intraoperative complications were also recorded.

Results:

For the MyKnee group, 21 patients had pre-operative varus deformities with a mechanical alignment of 7.8° (range 1.2°-15.2°). 7 patients had Pre-operative valgus deformities averaging 6.9° (range 1.3°-14.5°). 2 patients were neutral. Post-operative alignment for all patients (n=23) was varus 1.92° (range 0°-5.8°). 78% of patients were within 3° and 97% of patients were within 3.6°. Only 1 patient was outside 3.6°, measuring 5.4° valgus (Figure 3).

In comparison, the Standard TKA group had 21 patients with pre-operative varus deformities averaging 7.3° (range 0°-16.5°) while 7 knees were valgus 6.3° (range 1.2°-10.6°) and one was neutral. Post-operative alignment for these patients measured varus 1.85°. 79% of patients were within 3°; however the outliers were much more dramatic ranging 3.5°-9.2°.

30 Femora and 21 Tibial resections were available for review using the MyKnee technique. The Actual vs. Planned resections for the Distal Medial Femoral resection was 9.5 vs. 9.1mm respectively. Further Actual vs. Planned Femoral resections include Distal Lateral Femoral 8.4 vs. 6.3mm; Posterior Medial Femoral 9.3 vs. 9.5mm; and Posterior Lateral Femoral 8.6 vs. 7.0mm. The Actual vs. Planned Tibial resections recorded include Medial 6.07 vs. 6.29mm and Lateral 9.36 vs. 8.19mm.

Statistically, there is no significant difference in post-op degree (1.85° vs. 1.92°). Tourniquet time (TT) averaged 32.97 minutes in the Standard TKA group vs. 37.03 minutes in the MyKnee group, which isn't significantly different. However, the final 15 MyKnee patients had an average time of 33.46 minutes. EBL was minimal each cohort. No intraoperative complications were recorded in either group.

Discussion:

Many techniques exist for performance of TKA. The present study shows definitively that Intraoperative resections and Post-operative alignments can be accurately achieved with pre-operative CT planning and using Patient-Specific Instrumentation. In conclusion, using Patient-Specific Instrumentation is safe, quick, and accurate in performance of TKA.

Figure 1: MyKnee Patient-specific Instrumentation

Figure 2: Pre-op vs. Post-op Mechanical Axis (HKA)

Figures

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Figure 1 HYPERLINK "http://app.istaonline.org/figures/409.jpg" \t "_blank"
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Figure 2

3B : Hip mechanics: #922 September 21st, 2011, 13:50-14:40

Medulloscopy to Evaluate Canal Preparation in Primary THA

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Abstract

Background:

Cemented femoral stems have an excellent long-term outcome. Modern cement techniques should be used to optimize femoral stem fixation. Bleeding from the bone surface during cemented hip arthroplasty compromises the bone-cement interface. However, no studies have examined this bleeding in vivo nor the effect the different cleaning methods used. In the present study we evaluated bleeding patterns and efficacy of cleaning methods used in third generation cementing techniques.

Methods:

We prospectively performed a medulloscopy with a 10 mm laparoscope in 200 primary hip arthroplasties. Intramedullary bleeding was evaluated after femoral canal preparation and use of the different cleaning methods. The femoral canal was divided into three areas to facilitate comparison. The intramedullary bleeding was standardized on a four point scale. A non-parametric repeated measures ANOVA was used for statistical analysis.

Results:

Cotton swabs and brushes did not reduce the intramedullary bleeding significantly after broaching of the canal. Compared to these standard cleaning methods, pulsed lavage and the addition of brushing provided better blood removal ($p<0.001$). There was a trend, although not statistical significant ($p=0.24$), towards better canal cleaning if a canal filling tampon with suction was added. Arterial bleeding originating from the posterior wall of the canal was noticed in 26 cases (13 percent). These could only be controlled by diathermy tools.

Conclusion:

Most standard preparation techniques are insufficient to prepare the femoral canal before cement insertion. In case of severe intramedullary bleeding, an arterial bleeding should be ruled out and if necessary treated with the aid of diathermy tools. We recommend pulsed lavage combined with a brush and a canal filling tampon for femoral canal preparation in cemented primary hip arthroplasty for optimal reduction of intramedullary bleeding.

15B : Bearing materials: #904 September 23rd, 2011, 14:50-15:40

Squeaking in Ceramic-on-Ceramic Hips Can Be Related to Periprosthetic Bone.

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Introduction:

Increasing numbers and incidence rates of noisy (squeaking, scratching or clicking) ceramic-on-ceramic (CoC) total hip arthroplasties (THA) are being reported. The etiology seems to always involve stripe wear producing a stick-slip effect in the bearing which excites vibrations. As stripe wear is also found in silent CoC bearings, a theory has been developed that the vibrations become audible only via amplification through the vibrating stem. This was supported by showing that the excitation frequency and the resonance frequency of the plain stem are similar [1]. However, stem resonance in-vivo would be influenced by the periprosthetic bone damping and transmitting stem vibrations. Thus, if stem resonance is conditional for noisy COC hips, these should show periprosthetic bone different to silent hips.

This study compares stem fit&fill and periprosthetic bone between noisy and silent CoC hips.

Methods:

In a consecutive series of 186 primary CoC hips with identical stems, cups (Stryker ABG-II) and femoral heads (Alumina V40, 28mm) a dedicated patient questionnaire [2] identified 38 noisy hips (incidence rate: 20.4%, squeakers: n=23). Stem fit&fill and cortical wall thickness (CWT, medial and lateral) were measured on post-op AP x-rays according to an established method [3, Fig 1]. Measurements were repeated by a single blinded observer in a control group of silent hips matched for gender, age, stem size and follow-up time (4.6yrs). Fit&fill and CWT were compared between the noisy and silent group at proximal, mid-stem and distal level and on the medial and lateral side.

Results:

The endosteal canal width was equal in noisy (N) and silent hips (S) at all levels (e.g. proximal: N=39.7±5.5mm, S=41.3±5.7mm, Fig 2). On the lateral side also cortical wall thickness (CWT) was the same at all levels (e.g. proximal: N=2.0±0.8mm, S=1.9±0.9mm). However, on the medial side, noisy hips had higher CWT at proximal (N=4.9±2.8mm, S=3.0±2.1mm, $p<0.01$) and mid-stem level (N=6.2±2.1mm, N=4.6±1.7mm, $p<0.001$). Also Fit&fill was slightly higher (proximal: N=66%, S=62%; mid-stem: N=63%, S=59%, $p<0.05$). Differences and significance levels increased when in the noise group only squeakers were considered.

The mid-stem line, assumed to sit distal to LT, actually cut through LT significantly more often in the noisy (18/38) than in the silent group (9/38, $p=0.02$) indicating a tendency of noisy stems to sit more proximally.

Discussion:

Despite equal endosteal canal widths and lateral cortical wall thickness for noisy and silent hips, noisy hips had significantly thicker medial walls at proximal (+63%) and mid-stem level (+35%) where also fit&fill was higher. Noisy stems also sat more proximal (Fig. 3).

This gives evidence that periprosthetic bone (PPB) may play a role in the development of audible noise in CoC hips by providing particular conditions of support, damping and transmission for an oscillating stem which influences noise frequency and intensity. Comparing PPB at different time points indicated that the differences are less due to post-op remodeling but more to pre-op conditions o

References:

1 Hothan et al. Paper 236, ORS 2011

2 Grimm et al. Paper F13, EFORT 2008

3 Kim and Kim JBJS-B 1993

Figures

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Figure 6

6B : Survival / Outcome: #871 September 22nd, 2011, 8:30-9:35

Evaluating Different Functional Outcome Measures: Clinician-Administered Scales vs. Patient-Administered Outcome Measures vs. Objective Functional Tests.

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Introduction:

Patient satisfaction becomes an important aspect in clinical practice causing a shift from clinician-administered scales (CAS) towards patient-administered measurement outcomes (PROMs). Besides, clinical outcome can objectively be evaluated using inertia-based motion analysis (IMA). This study evaluates different outcome measures by investigating the 1) effect of replacing CAS by PROMS on outcome assessment, 2) redundancy between scales, 3) additional value of IMA in outcome scoring.

Methods:

This cross-sectional study included 27 primary unilateral total knee arthroplasty patients (m/f=12/19; age=66.2 yrs), 6 weeks (n=12) and 6 months (n=15) postoperative, who covered a wide range of the scores. One CAS (Knee Society Score (KSS; knee and function subscore), two PROMs (Knee Injury and Osteoarthritis Outcome Score Physical Shortform (KOOS-PS), Visual Analogue Scale satisfaction (VAS)) and a functional test (IMA block step test) were completed. For IMA, patients stepped up and down a 20cm block starting with the affected and followed by the non-affected leg, while wearing an inertia-sensor (3D accelero- and gyrometer) at the lower back (fig.1). IMA-parameters like performance time (s), bending angle (°), pelvic-obliquity angle (°), were calculated using self-designed algorithms. Differences between legs were determined by ratios (affected/non-affected leg). Pearson's correlations were done, considering $r<0.4$ poor, $0.4<r<0.7$ moderate, $r>0.7$ strong.

Results:

KSS-subscores and KOOS-PS encountered a broad range of the total scale (e.g. KSS-function [40-100]), while VAS-satisfaction range was limited [0-3]. Most questionnaires were moderately intercorrelated (r-range 0.4-0.6). Correlations were lacking between VAS-satisfaction and KSS-subscores. The KSS-function correlated most with IMA-parameters (r-range 0.4-0.5). VAS-satisfaction and KOOS-PS correlated only with one IMA parameters (resp. pelvic-obliquity ratio, time-to-perform). Correlations were lacking between KSS-knee and IMA (table 1). For all correlations applies that a better outcome in one score was associated with a better outcome in the other score.

Discussion:

The correlations between KOOS-PS and KSS-subscores indicate that they capture similar aspects of function, showing redundancy. VAS-satisfaction correlated with KOOS-PS but not with KSS-subscores, showing that KOOS-PS captures some satisfactory dimensions, which are lacking with KSS. The strongest correlation with VAS-satisfaction was found with IMA pelvic-obliquity ratio, a measure showing asymmetry in unilateral pathologies, indicating that satisfaction is best captured by IMA. Most correlations with IMA-parameters were found for KSS-function showing that KSS-function, which is the PROM like part of the KSS, is the most objective questionnaire-based measure. The KSS-knee lacked any correlation with IMA showing that clinician-based measurements are not so relevant to patients and not related to objective measures either. Also the KOOS-

PS lacks objective aspects of function as was shown by the limited amount of correlations with IMA. This may be due to the lack of stair climbing assessment in the KOOS-PS in contrary to KSS-function.

Conclusions:

The shift from CAS to PROMs may result in a loss of (objective) information, but will add a satisfaction aspect. Improvements in PROMS (e.g. add moderate-demanding activities like stair climbing) are therefore recommended. The use of IMA may be an alternative as it provides an objective assessment capturing satisfaction and PROMs-like (KSS-function) aspects. Thereby, CAS will be improved (e.g. new KSS) which may be promising as well.

Figures

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Figure 4

2A : CAOS session: #1039 September 21st, 2011, 11:15-12:05

Can the Future Bring TKR Without Implant Specific Instruments?

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Introduction:

Computer aided surgery aims to improve surgical outcomes with image-based guidance. Navigated Freehand bone Cutting (NFC) takes this further by eliminating the need for cumbersome mechanical jigs. Multiple previous experiments on plastic and porcine bones, performed by surgeons with different level of expertise, suggested that the NFC technique was feasible. This study pushes NFC further by using the technique to perform complete total knee replacement (TKR) surgeries on cadavers (including implant cementing of tibia and femur).

Materials and Methods:

A single surgeon performed a series of TKR surgeries on full cadaveric legs. Cruciate sacrificing implants were selected because these were considered more challenging for a freehand cutting approach due to the extra number and complexity of the cuts needed around a posterior stabilizing post recess when present.

A proprietary NFC prototype system was used, with real time graphics to indicate where/how to cut the bone without jigs. The system comprised a navigated smart oscillating saw, reciprocating saw and drill without any of the conventional jigs typically used in TKR.

The tasks performed included (and were grouped) to include pre-surgical planning, incision, placement of navigation pins & markers on tibia and femur, bone registration, marking and cutting, cut surface digitization (for quality assessment), implant placement and cementing, assessment of implant fit and location, and pin removal and wound closing.

Results:

Experiments ran smoothly without software, hardware, or workflow (logic) failures. One tibia required re-registration after failing the registration validation process, and one reflective ball on the smart saw had to be replaced during surgery due to a defective fastening. Overall average surgery time was 1 hour and 20 minutes. The cutting process took the most time (31% of total time) followed by cementing and bone registration (14% and 12%, respectively). Surface smoothness of the bone cuts on human cadavers was better than what was previously obtained for synthetic bone.

Discussion and Conclusion:

The results indicate that Navigated Freehand Cutting technology could eventually be used on patients, as surgical time, implant alignment, cut quality, and other metrics are consistent or better than those of conventional approaches, even with this prototype system. New computer-human interfaces under development are expected to

reduced cutting, registration, digitization times, promising a faster overall surgery. We speculate that Navigated Freehand Cutting (NFC) is no longer a dream, no longer just feasible, but on the way to clinical trials not too far in the future.

Figures

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Figure 1

14B : Revision and difficult cases - Hip: #575 September 23rd, 2011, 13:50-14:40

Mobilization by Means of Uncemented Hip Arthroplasty for Arthrodesed or Ankylotic Hips

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Hiroshi Sunami - Ebina General Hospital - Ebina, Japan
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Introduction:

Conversion of immovable hip to a total hip arthroplasty provides a solution, improving function, reducing back and knee pain, and slowing degeneration of neighboring joints associated with hip dysfunction while the mobilization by total hip arthroplasty is rather uncommon and challenging surgery.

Materials and methods:

Since 1998 we have performed 28 uncemented total hip arthroplasties for arthrodesed or ankylotic Hip. Among them 25 hips in 24 patients (four males and 20 females) with minimum of six months follow-up were evaluated. Thirteen hips were arthrodesed and twelve hips were ankylotic. One patient had arthrodesed hip in one side and ankylotic one in the other side. The mean age at the surgery was 63 (42 to 80). Two patients were Jehovah's witnesses. All 13 arthrodeses had been performed at other hospitals due to developmental dysplasia (11 hips), tuberculous coxitis (one hip), and infection after osteotomy (one hip). The underlying disease for the ankylosis was tuberculous coxitis for one hip and dysplastic osteoarthritis for 12 hips. Spongiosa Metal Cup (GHE, ESKA Orthodynamics AG, Lübeck, Germany) was used for 21 hips (screw fixation was added for two hips), Alloclassic Cup (Zimmer GmbH, Winterthur, Switherland) for one hip, Bicon Plus Cup (Smith & Nephew AG, Rotkreuz, Switherland) for one hip, and Müller's Reinforcement Ring (Zimmer GmbH, Winterthur, Switherland) for two hips. The bearing couple was ceramic on ceramic (Biolox forte, Ceramtec AG, Prochingen, Germany) for 14 hips, ceramic on polyethylene for eight hips, and metal on metal for three hips. Spongiosa Metal Stem (GHE, ESKA Orthodynamics AG, Lübeck, Germany) was used for 15 hips, SL Plus Stems (Smith & Nephew AG, Rotkreuz, Switherland) for nine hips, and Alloclassic Stem (Zimmer GmbH, Winterthur, Switherland) for one hip. All surgeries were carried out through an anterolateral approach. Twelve hips required the adductor tenotomy against the stiffness. The average follow-up period was 3.7 (0.5 to 10.6) years.

Result:

The average total blood loss during total hip arthroplasty was 685 (150 to 2042) milliliters and the average operative time was 102 (64 to 178) minutes. A perforation occurred in one femur. In this patient a plate (used for the previous arthrodesis) was buried in the femoral cortex. Trochanteric fracture occurred in another hip. The average post-operative range of motion was 65 (35 to 100) degrees in flexion, 2 (-10 to 15) in extension, 18 (5 to 30) in abduction, 10 (5 to 20) in adduction, 25 (10 to 45) in external rotation, and 14 (-5 to 30) in internal rotation. We had no postoperative dislocation. One patient required one-stage revision because of the recurrent infection at three years after the primary total hip arthroplasty. In all other patients the implants were stable at the final follow-up.

Conclusions:

An immovable hip brings about a lot of inconveniences. Though the surgery involved technical difficulties, it

provided a better quality of life for the patients. Mobilization by means of uncemented total hip arthroplasty can be carried out successfully for immovable hips.

1A : Kinematics and Wear-knee: #708 September 21st, 2011, 8:30-9:35

Results From a New Method for Obtaining in Vivo Fluoroscopic Arthoplasty Evaulations With Normal Patient Movement

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Commercial C-arm fluoroscopes are routinely used to analyze human skeletal joints during motions such as deep knee bends, or chair rises. Such diagnostics are used to characterize pre and post operative arthoplasty results, particularly in association with total joint replacement procedures. Stationary fluoroscopes restrict the patient motion and load conditions, thus diminishing the diagnostic utility of the results. A new class of fluoroscopy has been developed in which a robotic mechanization is used to allow selected joints to be x-rayed while the human subjects perform natural motions such as walking. The tracking fluoroscope system (TFS) is a mobile robot that acquires real-time x-ray records of hip, knee, or ankle joint motion while the patient walks normally. Because the fluoroscope line of sight dynamically tracks the joint of interest, the TFS provides clearer and contained joint images.

The technical features of the TFS will be reviewed, recent development testing summarized, and the results of preliminary patient trials presented.

7B : Shoulder: #840 September 22nd, 2011, 11:15-12:05

Shoulder Muscle Coordination and Activation During a Rotational Task Based on an Activity of Daily Living: An Electromyographic Study

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Introduction:

Shoulder motion results from a complex interaction between the interconnected segments of the shoulder girdle. Coordination is necessary for normal shoulder function and is achieved by synchronous and coordinated muscle activity. During rotational movements, the humeral head translates on the glenoid fossa in the anterior-posterior plane. Tension developed by the rotator cuff muscles compresses the humeral head into the glenoid fossa. This acts to limit the degree of humeral head translation and establishes a stable GH fulcrum about which the arm can be moved. Previous studies have been limited by the use of contrived movement protocols and muscular coordination has not been previously considered with regard to shoulder rotation movements. This study reports the activation profile and coordination of 13 muscles and 4 muscle groups during a dynamic rotational movement task based on activities of daily living.

Methods:

Eleven healthy male volunteers were included in the study. Electromyography (EMG) was recorded from 13 muscles (10 surface and 3 fine-wire intramuscular electrodes) using a wireless EMG system. EMG was recorded during a movement task in which the shoulder was consecutively rotated internally (phase 1) and externally (phase 2) with a weight in the hand. Muscle group data was calculated by ensemble averaging the activity of the individual component muscles. Mean signal amplitude and Pearson correlation coefficient (PCC) analysed muscle activation and coordination, respectively.

Results:

The mean length of phase 1 (internal rotation) and phase 2 (external rotation) was 1.1s (SD+0.15) and 1.09s (SD

+0.18), respectively with no significant difference between them. Mean signal amplitude was significantly higher during external rotation for the anterior, middle and posterior deltoid, teres major and the rotator cuff muscles (Table 1). Significant positive correlations were identified between the activation patterns of the deltoid and rotator cuff groups (PCC=0.95, p=<0.001), the deltoid and latissimus dorsi-teres major groups (PCC=0.74, p=<0.001) and the latissimus dorsi-teres major and rotator cuff groups (PCC=0.87, p=<0.001) (Figure1).

Discussion:

The subscapularis is extensively described as an internal rotator of the glenohumeral joint; however, during this study it was primarily active during external rotation. During activities of daily living the subscapularis balances the force generated by the supraspinatus and infraspinatus by contracting eccentrically as external rotation progresses. This balance between the anterior and posterior rotator cuff maintains anterior-posterior stability of the humeral head on the glenoid fossa. There is a highly coordinated and synchronous relationship between all the major muscle groups of the shoulder during rotational activities, which ensures glenohumeral joint stability. The function of the shoulder muscles is task specific. This has important implications when considering the impact of muscle pathology on shoulder dysfunction and the treatment strategies employed.

Figures

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Figure 3

Flexion and Extension Laxity After Mobile Bearing Unicondylar Knee Arthroplasty: A Comparison Between a Spacer and a Tension-Guided Technique

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Background:

In a mobile-bearing unicondylar knee arthroplasty (UKA) stability is very important for the knee function and to prevent dislocation of the insert. A tension-guided technique to determine the position of the optimal posterior bone cut should theoretically lead to a better varus-valgus stability. The goal of this study was to measure the difference in valgus laxity in flexion and extension between a tension-guided and spacer-guided system for mobile-bearing UKA. Also clinical function was evaluated between the groups.

Patients and Methods:

A tension-guided UKA system (BalanSys^{TM}, Mathys, Bettlach, Switzerland) was compared with a retrospective group of a spacer-guided system (Oxford, Biomet Ltd, Bridgend, UK). A total of 30 tension-guided UKAs were placed and compared to 35 spacer-guided prostheses. Valgus laxity was measured at least 6 months postoperatively in both groups using stress radiographs. The flexion stress radiographs were made fluoroscopically aided in 70 degrees of knee flexion. Laxity measurements in extension were performed on stress radiographs obtained with the Telos device. Knee Society Scores (KSS) were obtained at follow-up.

Results:

Valgus laxity in flexion was significantly higher in the tension-guided group compared to the spacer-guided group: 3.9° and 2.4°, respectively, p<0.001) In extension, valgus laxity was 1.8° in the tension-guided group compared to 2.7° in the spacer-guided group, which was significantly different (p<0.001) . There was no significant difference between the two groups in the KSS at 6 months follow-up. (p=0.31)

Discussion and conclusion:

The tensor-guided system resulted in significantly more valgus laxity in flexion compared to the spacer-guided system. However, in extension the situation was reversed: the tension-guided system resulted in less valgus laxity

than the spacer-guided system. Clinically, there were no differences between the groups. The valgus laxity found with the spacer-guided system better approximates the valgus laxity values of healthy elderly.

8A : Knee arthroplasty: #817 September 22nd, 2011, 13:55-14:45

Kinematics of an Anatomically Designed Cruciate-Retaining Total Knee Arthroplasty Implanted Using a Spacer-Guided PCL Balancing Technique.

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Pius Wong - European Centre for Knee Research, Smith & Nephew - Leuven, Belgium
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Introduction

After total knee arthroplasty (TKA) with a PCL-retaining implant the location of the tibiofemoral contact point should be restored in order to obtain normal kinematics. The difficulty during surgery is to control this location since the position of the femur on the tibia cannot easily be measured from the back of the joint. Therefore, we developed a simple “spacer technique” to check the contact point indirectly in 90° flexion after all bone cuts are made by measuring the step-off between the distal cut of the femur and the anterior edge of the tibia with a spacer in place. The goal of this experiment was to investigate whether this new PCL balancing approach with the spacer technique created the correct contact point location.

Methods

Nine fresh-frozen full leg cadaver specimens were used. After native testing, prototype components of a new PCL-retaining implant were implanted using navigation and a bone-referenced technique. After finishing the bone cuts of tibia and femur, the spacer was inserted in flexion and positioned on the anterior edge of the bony surface to measure the step-off. If necessary, an extra cut was made to balance the PCL.

The specimen was mounted on the knee kinematics rig and a squat with constant vertical ankle force (130N) and constant medial and lateral hamstrings forces (50N) was performed between 30° and 130° of knee flexion. The trajectories of the reflective tibial and femoral markers were continuously recorded using six infrared cameras. The projections of the femoral condylar centers on the horizontal plane of the tibia were calculated and compared.

Results

Of the 9 specimens, the calculated step-off was correct in 7 after finishing the bone cuts and in 2 specimens an additional tibia cut with 2-3 degrees more slope was sufficient to achieve the correct step-off. No lift-off of the tibial tray occurred during the tests. The patterns of the kinematics of the native and replaced knee showed a considerable similarity (fig 1). The projected medial femoral condylar center of the knee implant is at the same position as the projected medial femoral condylar center of the native knee. No paradoxical roll forward is seen in the knee implants, showing that the PCL balancing apparently seems to work quite well. The projected lateral femoral condylar center of the knee has a similar kinematic pattern in flexion before and after TKA. The knee implant shows a slightly more anterior location near extension but this is only marginal.

Discussion and conclusion

The kinematics of the PCL-retaining implant are on average comparable to the kinematic pattern of the native knee. Apparently, the joint surfaces of the anatomic knee designed with a dished medial insert surface and a convex lateral insert surface and a 3 degrees varus of the joint line is guiding the motion towards that of a normal knee joint. We feel that correct balancing of the PCL during implantation is of major importance in achieving these results. The spacer technique to balance the PCL seems to work well in this experiment.

Figures

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Figure 2

1B : MIS - Hip: #456 September 21st, 2011, 8:30-9:35

Evaluation of Complications of Mini Antero-Lateral Approach of Primary Total Hip Arthroplasty for Patients With DDH

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Purpose:

Dysplastic acetabulum (DDH) have some difficulty even if with conventional approach of THA. Indication or contraindication is not clear with MIS THA. The purpose of this study was to evaluate complications with mini antero-lateral approach for DDH patients.

Materials & Methods:

1523 DDH hips were evaluated. Follow-up periods were averaged 36 mos. (24-74). 612 were Crowe I, 628 of II, and 283 of III. Crowe IV hips were contra-indicated. Leg length discrepancy (LLD) before and after surgery, OR time, complications during and after surgery, and length of hospital stay were evaluated.

Results:

Average LLD before surgery was 1.3cm in Crowe I, 1.8cm in II, 3.3cm in III, but recovered within 5 mm after surgery. Average OR time was 56 minutes, 68, and 96 ($p<0.05$), respectively. Crowe II with contractured hips had more OR time (>75 min) compared to no contractured hips (<65 min) ($p<0.05$). Three of type I, 4 of II, 6 of III with osteoporosis and contractured hip patients had posterior trochanteric tip fracture within 2 weeks because of disuse bone atrophy or obesity (BMI>30). Two acetabular cups were revised with Crowe III because of surgical errors. We had 8 dislocations, 2 infections and 12 anterior calcar linear fractures, but fixed with wiring. No other complication has occurred. After 300 cases, lerning curve was stable around 60 minutes in skin to skin surgical time. Harris hip score was improved 92 at the final follow-up.

Discussion & Conclusion:

Crowe I and II patients had no severe complication. Care must be taken for Crowe III with 2.5cm or more LLD with contractured hip, severe osteoporosis, or anteverted femoral neck. These type of patients need to change conventional approach. Capsular release around piriformis fossa need to make a proper alignment before stem broaching. Care must be taken for obtaining proper combined anteversion of DDH with higher femoral neck anteversion.

14B : Revision and difficult cases - Hip: #458 September 23rd, 2011, 13:50-14:40

Effect and Safety of 3.5 Cm Total Length of Correction in Primary Total Hip Arthroplasty for Crowe IV Patients

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Purpose:

Crowe IV complete dislocated hips were thought to be difficult for primary THA. Correction for leg length discrepancy associated with nerve palsy or tough to reduction during surgery. Purpose of this study was to evaluate 3.5cm total leg length correction for any type of Crowe IV patients setting in anatomical positioning of acetabular cup with femoral shortening osteotomy.

Materials & Methods:

24 hips were evaluated averaged 28 months after primary THA. Correction length of center of rotation, amount of femoral shortening, Harris hip score, and abductor muscle power recovery with MicroFet 2 calculator. Bilateral cases were preformed with 6 months interval. Length of femur and tibia compared to contralateral normal side were evaluated from plain radiograms.

Results:

Average LLD before surgery was 7.3 (5 to 8.5) cm, but recovered within 3.5 cm (0.8 to 2.9) after surgery. One cm longer of femur in 9 patients, one cm longer of tibia in 12 patients, and 1cm longer both of femur and tibia in 5 patients compared to contralateral side before surgery. Average OR time was 92 minutes. All patients were

women averaged age was 60 (34 to 75). Harris hip score improved from 45 to 92 before and latest follow-up. All patients did not need t-cane 2 years after surgery. Center of rotation was averaged 6.8 (5.2 to 8.1) cm reducted to anatomical position. Femoral shortening averaged 3.3 (1.7 to 4.5) cm, so total correction was 3.5cm (3.1-4.2). No nerve palsy and had good muscle recovery without T-cane. Patients with normal contra lateral side had averaged 2 cm (1.5~3) heel up orthosis after surgery, but had no complaint about heel up situation in activity of daily living.

Discussion & Conclusion:

Amount of correction with leg length discrepancy during THA had controversial issues especially in cases of completed dislocated hip joint. Several authors demonstrated that muscle-evoked potentials elicited by brain electric stimulation monitoring, but problems occurred during epidural or spinal anesthesia. Averaged 3.5cm Total correction of leg length was very safe and satisfactory results for all Crowe IV patients.

12A : Knee Mechanics: #453 September 23rd, 2011, 8:30-9:35

Calculation of the Forces Acting on the Knee Joint When Rising From a Kneeling Position (Effects of the Leg Alignment and Using Arms on the Knee Joint Force)

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The objective of this study is to determine the knee joint forces when rising from a kneeling position. We have developed a new type of knee prosthesis which is capable of attaining Japanese style sitting. To run the simulations and experiments needed to assess the performance of this prosthesis, it is necessary to know what forces act on the knee during deep flexion. Because these data are lacking, we created a 2D mathematical model of the lower leg to help determine knee joint forces during deep flexion. Healthy subjects of ten males (age of 25±4years, height of 170.3±9.1cm, and weight of 67.0±22.2kg) and five females (25±3years, 161±7.1cm, 47.7±6.2kg) participated in the experiment. Ground reaction force and joints angles were measured using a force plate and a motion recording system respectively. The collected data were entered into our mathematical model, and the muscle forces and the knee joint forces were calculated. To verify our model, we first used it to run simulation of middle and high flexions of the knee joint. In vivo data for these actions are available in the literature, and the results from our simulation were in good agreement with these data. We then collected the data and run simulation when rising from a kneeling position under the conditions shown in Fig.1. They were a) double leg rising (both legs are aligned) without using the arms, b) ditto but using the arms, c) single leg rising (legs are in the front and the rear respectively) without using the arms, and d) ditto but using the arms. We obtained the following results. The statistics of the maximum values on the single knee joint for each condition were; a) F_{max}=5.1±0.4 [BW: (force on the knee joint)/(body weight)] at knee flexion angle of Q=140±8°, b) F_{max}=3.2±0.9[BW] at Q=90±10°, c) $F_{max\text{-}d}$=5.4±0.5[BW] at Q_d=62±20° for the dominant leg and $F_{max\text{-}s}$=3.0±0.5[BW] at Q_s=138±6° for the supporting leg respectively, and d) $F_{max\text{-}d}$=3.9±1.5[BW] at Q_d=70±17° for the dominant, and $F_{max\text{-}s}$=2.1±0.5 [BW] at Q_s=130±11° for the supporting. We may conclude that the single leg rising should be recommended since the maximum knee joint force did not become large as long as the knee was at deep flexion. The values introduced in this study could be used to assess the strength of the knee prosthesis at deep flexion. To obtain more realistic values of the joint forces, it is necessary to determine the ratio of the forces exerted by the mono-articular and the bi-articular joint muscles.

Figures

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Figure 1

15A : Alternative treatments: #820 September 23rd, 2011, 14:50-15:40

Characterisation of TRUFIT® Hydrogel Materials for Knee Repair Purposes

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Introduction

Novel hydrogel implants, TRUFIT® bone plugs, have been developed by Smith & Nephew to replace worn-out cartilage surfaces, restoring mobility and relieving joint pain. There is limited information, however, on the biomechanical properties of the implants. Therefore, appropriate mechanical testing and modelling must be carried out to assess their mechanical properties for load bearing applications.

In this study, compressive properties of TRUFIT® bone and dual layer implants were examined under selected physiological loading conditions. The bone layer of the implant was also modelled using a biphasic poroviscoelastic (BPVE) material constitutive law and the results from the model are compared with those from the experiments.

Materials and Methods

TRUFIT® CB plugs, with diameters of 11 and 5mm, were sectioned to obtain single layer bone and dual layer samples, with an aspect ratio of 0.86. Specimens were tested in confined and unconfined compressions at two constant strain rates of 0.002/sec (walking) and 0.1/sec (impact) [1-3] on a MTS servo-hydraulic test machine equipped with a bionix envirobath. All samples were tested in phosphate buffered saline (PBS) solution at 37 ^{o}C. A preload of 0.1 MPa was applied and preconditioning (10 cycles of 0.008 strain) at a constant strain rate of 0.005 sec^{-1} [4] was used. The compressive modulus was calculated from the slope of the linear part of the stress-strain curve. In addition, whilst stress relaxation tests were performed on the bone samples in unconfined compression up to 5% strain, at a strain rate of 0.01/s (running) [1-2].

Biphasic Modelling

The bone implant was modelled as a biphasic poroviscoelastic (BPVE) material assuming constant permeability and linear viscoelasticty. An axisymmetric finite element model of the implant in unconfined compression was built using FEBio [5], with 8-node tri-linear displacement and pore pressure elements. The governing equations for linear BPVE theory are summarized in [6]. Six material coefficients were obtained to describe the model, as shown in Table 1. E and μ are the Young's modulus and Poisson coefficient of the solid matrix; k is the hydraulic permeability; G*, t_1 and t_2 represent the discrete relaxation spectrum magnitude and time relaxation constants used to describe the intrinsic viscoelastic nature of the solid matrix. The Young's modulus of the solid matrix was calculated from the equilibrium stress versus strain in the linear range. The Poisson coefficient of the porous solid matrix was determined also from 3D in situ step-wise compressive tests using Digital Volume Correlation. Permeability measurements were performed, where steady state flow rate versus pressure gradient was measured and the hydraulic permeability was calculated using the Darcy's law. An inverse iterative FE technique was used to identify the remaining coefficients from the stress relaxation experiments.

Results & discussion

The compressive moduli are summarized in Fig 1. The preliminary results seem to suggest that strain rate seems to have a dominant effect on compressive modulus. Higher strain rate would always result in higher modulus. On the other hand, the influence of confinement seems to be small. Higher moduli were observed for bones. Smaller sized (5mm) bone samples seem to have a higher modulus at both strain rates. For plugs, significantly higher modulus was found for 5mm samples in walking but similar results were obtained in impact.

Fig. 2 shows a typical curve fitting exercise of the BPVE model using the experimentally determined stress relaxation curve (R^2=0.95), from which model parameters were obtained. The BPVE model is able to account for the initial, transient and stationary regime of stress relaxation. Moreover, the model is able to reproduce the monotonic unconfined compressive responses at two strain rates (walking and impact), as illustrated in Fig. 3.

Acknowledgements

The authors would like to thank Smith & Nephew for providing the samples.

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Fig 1 Compressive modulus of TRUFIT bones and bone/cartilage plugs in selected testing conditions.

Fig 2 Typical experimental stress relaxation response of the implant and BPVE model simulation.

Fig 3 Experimental and simulated stress vs. strain responses of the bone implant, unconfined compression.

Table1: BPVE coefficients of the scaffold implant.

Figures

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Figure 8

In Vitro Metal-on-Metal Subluxation Test

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Metal-on-Metal devices generate significantly lower volumetric wear than conventional total hip replacements. However, clinically some patients may suffer some form of laxity in their joints leading to subluxation of the joint, which in turn may cause edge loading of an implant thereby increasing the chances of failure due to higher than expected wear.

In this study, the effect of subluxation on MoM implant wear was investigated on a hip joint simulator.

Materials & Methods

Two groups of 44 mm MoM devices were tested, n=3 in each group. The devices were subjected to 1 and 2 mm of subluxation. The flexion/extension was 30° and 15° respectively, internal/external rotation was ±10°, and cup inclination was 35°. The force was Paul type stance phase loading with a maximum load of 3 kN, with ISO swing phase load of 0.3 kN, run at 1 Hz .

The test was carried out on a ProSim deep flexion & subluxation hip wear simulator (SimSol, UK). Rather than separating the head and the cup (microseparation), or reducing the swing phase load, this simulator is equipped with a novel mechanism to achieve translation of the head, while subjecting the devices to subluxation. During the swing phase, a controlled lateral force necessary for the translation of the head is applied by a cam mechanism, head retraction will then take place on heel strike.

The lubricant used was new born calf serum with 0.2 wt. % sodium azide concentration diluted with de-ionised water to achieve average protein concentration of 20 g/l. Lubricant was changed every 250k cycles. Gravimetric wear measurements have been taken at 0.25 & 0.5 Mc stages.

Results

Tests conducted with 1mm (Group 1) and 2mm (Group 2) subluxation significantly increased volumetric wear compared to standard hip simulator tests [1]. At 0.5 million cycles, group 1 and 2 produced an average volume loss of 4.38±0.98 mm^3 (95% CL) and 7.07±1.64 mm^3 (95% CL) respectively.

Discussion/conclusion

Well positioned and well-fixed hip implants perform well *in vitro* and *in vivo*; however optimal performance a device can be affected by a number of factors from design, technical factors, patient factors, surgical technique to position of the device *in vivo*.

The study presents test results of a hip joint simulator with a subluxation mechanism to simulate clinically relevant subluxation during the swing phase of a gait cycle under the ISO swing phase load of 0.3kN, with differing levels of luxation. Increasing the level of subluxation in turn increased volumetric wear due to greater head contact at the superior rim of the cup. Further tests will be conducted with high cup inclination angles (>45°) and subluxation to determine the effect upon wear. Tests which can simulate the (ideal and adverse) conditions clinically can help to improve the design and understanding of implant behaviour *in vivo*.

Reference:[1] Hussain *et al,* Edge Loading of Retrieved MoM Resurfacing Acetabular Cups, ORS 2011

Figures

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Figure 1

Keynote Lecture 5 : Fast-Track Hip and Knee Arthroplasty: Current Status and Future Challengesby Hen: #1080 September 22nd, 2011, 11:00-11:15

Fast-Track Hip and Knee Arthroplasty: Current Status and Future Challenges

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Abstract, ISTA, Friday 22.nd of September 11.00-11.20, Fast track THA and TKA

Abstract title: **"Fast-track hip and knee arthroplasty: current status and future challenges".**

Author: Henrik Husted, MD, Denmark

Abstract: Fast-track THA and TKA is a dynamic process combining clinical and logistical enhancements to ensure the best outcome for all patients regarding faster early functional recovery and reduced morbidity. Focus is on reducing convalescence by ensuring a smooth pathway with the best available clinical treatment from admission to discharge – and beyond. Main focus areas include pain treatment, mobilization, organizational aspects, traditions, and care principles. Outcome is typically evaluated as: a) length of stay in hospital (LOS), patient satisfaction, and reduced convalescence in the form of earlier achievement of functional milestones; b) safety aspects (reduced morbidity and mortality in the form of complications and readmissions in general and dislocations/manipulations in specific); c) feasibility (can the track be applied to other subgroups of patients, i.e. bilaterals or revisions?); and d) economic savings. Favorable outcomes regarding all these parameters have been documented for fast-track THA and TKA which has also resulted in the development of a Rapid Recovery Programme (Biomet).

This presentation will highlight the current status of fast-track THA and TKA with a kaleidoscopic overview of the documented best available treatment on the main focus areas as well as address future challenges for improving even further – which includes a revision of traditions and answering of the question: "why is the patient in hospital today?"

LOS is now 1-2 days for unselected patients in leading departments with few readmissions, high patient satisfaction and economic savings. In Denmark, the nationwide median LOS is now 4 days and improved logistic features include homogeneous entities, regular staff, high level of continuity, preoperative information including intended LOS, admission on the day of surgery and functional discharge criteria. The improved clinical features include both intraoperative (spinal anesthesia, local infiltration analgesia (LIA), plans for fluid therapy, small standard incisions, no drains, compression bandages and cooling) and postoperative (deep venous thrombosis prophylaxis starting 6-8 hours postoperatively, multimodal opioid-sparing analgesia, early mobilization and discharge when functional criteria are met) facilitating early rehabilitation and discharge.

Future challenges include identification of high-pain responders to improve multimodal pain treatment; identification of high-risk patients regarding complications in fast-track set-ups; how to reduce postoperative cognitive dysfunction; how to reduce orthostatic intolerance; and when how and to whom to initiate and give rehabilitation.

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13A : Robotics & navigation: #554 September 23rd, 2011, 11:15-12:05

May I Believe Neck Anteversion Observed Intra-Operatively? -Evaluation of in Vivo Position of the Stem Using 3D CAD-

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Introduction

To obtain a better range of motion and to reduce the risk of dislocation, neck and cup anteversion are considered very important. Especially for the reduction of the risk of dislocation, the mutual alignment between neck and cup anteversion (combined anteversion) is often discussed. A surgeon would compare the neck direction to the calf direction with the knee in 90 degrees flexion. When an excessive anteversion was observed, the neck anteversion would be reduced using modular neck system or setting the stem a little twisted inside the canal with the tradeoff of the stem stability. Another choice would be the adjustment of cup alignment. Combined anteversion is defined the summation of cup anteversion in axial plane and stem anteversion in axial plane. But in realty the impingement occurs with 3 dimensional relationships between neck and cup with very complicated geometries. In that meaning, the definition of the angles could be said ambiguous too. The bowing of the femur also makes the relationships more complicated. Upon those backgrounds, we have been performing 3D preoperative planning for total hip arthroplasty on every case. In the present study, in vivo position of the stem in each case was determined then the anteversion observed on surgical view and anteversion around femoral mechanical axis are compared using 3D CAD software.

Materials and Methods

Ten recent cases from our hip arthroplasty with 3D preoperative planning were reviewed for this purpose. The bone geometries were obtained from CAT scans with very low X-ray dose using Mimics® (Materialize, Belgium). Preoperative planning for Revelation stem® (DJO, USA) was performed using Mimics® (Materialize, Belgium). Femoral mechanical axis was defined as a line between center of femoral head and the middle point of medial and lateral epicondyle of the femur. Then mechanical anteversion is assessed from posterior condylar line. On the other hand, the calf was rotated 90 degrees around epiconlylar axis of each femur, and in vivo stem position was estimated then, stem axis was aligned perpendicular to the view. The anteversion in the surgical view was assessed from that view as the angle toward the calf. (Fig. 1) Using in vivo stem alignment, the impingement angle was also assessed.

Results

Anteversion was in average 10 degree overestimated in the surgical view. Only one case was considered to have impingement risk and reduction of the anteversion was performed using custom stem.

Discussion

In real surgical view, the anteversions are often observed to be more. In the present study instability of the knee was not considered. If the surgeon has performed inappropriate modification of the stem and cup anteversion, it can increase the risk of the dislocation and worse mechanical conditions. The in vivo prosthesis alignment should not be discussed with the angles from surgical view, but should be well planed 3 dimensionally preoperatively.

Figures

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Figure 1

Influence of Design on Potential Periprosthetic Stress Shielding: A Finite Element Analysis

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INTRODUCTION:

Patellofemoral joint (PFJ) replacement is a successful treatment option for isolated patellofemoral osteoarthritis. With this approach only the involved joint compartment is replaced and the femoro-tibial joint remains intact. Minimizing periprosthetic bone loss, which may occur due to the stress shielding effect of the femoral component, is important to insure long-term outcomes. The objective of this study was to investigate, using finite element analyses, the effects of patellofemoral replacement on the expected stress distribution of the distal femur eventually leading to changes in bone density.

METHODS:

MRI images of a healthy knee were acquired, segmented and reconstructed into a 3D physiological model of the bony and cartilaginous geometries of distal femur and patella with patellar tendon and insertion of the quadriceps tendon. This model was modified to include PFJ replacements with either a Journey PFJ or a Richards II PFJ prosthesis, and a Genesis II TKA (Smith&Nephew, Memphis, TN). The prosthetic components were incorporated in the intact model based on the manufacturer's instructions or previously described surgical techniques (Figure 1).

Cortical bone was modeled with orthotropic properties, while homogeneous linear isotropic elasticity was assumed for trabecular bone, cartilage, cement and femoral components materials. The patellar tendon was given Neo-Hookean behavior. UHMWPE patellar buttons for all designs were assigned non-linear elasto-plastic material.

The simulated motion consisted of a 10 second loaded squat, starting from 0° until a flexion angle of 120° matching experimental kinematics tests performed in previous in-vitro analysis on physiological cadaveric legs [1-2]. The patella model was constrained fixing the distal part of the patellar ligament and applying a quadriceps force distributed on the quadriceps insertion on the proximal surface of the patella.

During the dynamic simulation the average Von Mises stress was calculated in two regions of interest (ROI) defined in the femoral bone: one anterior and one proximal. The location of the ROIs was defined to fit the same regions as used in a previous bone mineral density analysis following patellofemoral arthroplasty (height 1cm, length 1cm).

RESULTS AND DISCUSSION:

Overall, the average bone stresses in both ROIs increased with flexion angle. Maximal stresses during squat were reached at 90° flexion angle, (2.8-3.8 MPa for the anterior ROI and 1.4-1.6 MPa for the proximal ROI). Mean stresses in the proximal ROI were similar for both PFJ designs and the physiological model, and slightly lower

for the TKA. Between 80° and 120°, anterior ROI bone stresses for Journey PFJ design were comparable to the physiological knee, while reduced by almost 25% for the other designs (Figure 1).

These results suggest a different stress-shielding behavior depending on design geometry and material properties.

CONCLUSIONS:

This study evaluated periprosthetic bone stress distributions of different patellofemoral replacements. The numerical analyses of physiological and replaced knee models predicted a decrease in stress behind the anterior flange of the femoral component for some designs. This reduction was dependent on prosthesis design geometry and materials properties.

Reference

1) Victor et al., AJSM 2009.

2) Victor et al., JOR 2010.

Figures

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Figure 2

12B : Hip arthroplasty: #522 September 23rd, 2011, 8:30-9:35

Intraoperative Radiography to Avoid Incomplete Seating of Trident Acetabular System Ceramic Liners

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Introduction

Alumina-on-alumina bearings exhibit low wear rates in vitro and one commonly used ceramic implant is the Trident system (Stryker, Mahwah, NJ). There are some reports of incomplete seating of the ceramic liner in the Trident acetabular shell. However, it is often difficult to detect incomplete seating intraoperatively. We sought to prevent incomplete seating using intraoperative radiography.

Materials and Methods

We retrospectively reviewed 19 hips in 17 patients who had undergone primary total hip arthroplasty using a Trident shell with a metal-backed alumina liner between 2007 and 2010. There were 16 women and 1 man, with an average age of 45.7 years. Preoperative diagnosis revealed 14 cases of osteoarthritis and 5 cases of osteonecrosis. All procedures were performed using a posterolateral approach with PSL cups. The minimum follow-up time was 12 months (average 28 months). All procedures included an intraoperative anteroposterior view radiograph to evaluate cup seating. If incomplete seating was recognized we reinserted the liner. Postoperatively, radiographs (supine anteroposterior and cross table lateral views) and computed tomography were performed in all cases in order to assess any residual incomplete seating. We investigated whether it was possible to avoid incomplete seating using intraoperative radiography.

Results

Six (32%)of 19 hips had evidence of incomplete seating. Of these, 3 revealed incomplete seating on intraoperative radiography, 2 were reinserted adequately, and the liner was replaced with a polyethylene liner in one case. Postoperative radiography revealed incomplete seating in 3 cases. One hip had become correctly seated as shown by follow-up radiography at 3 months and the other hips remained incompletely seated for the follow up period. The location of the gap between the socket and liner caused by incomplete seating was inferomedial in all cases, as seen on the intraoperative anteroposterior view radiographs. We were able to avoid incomplete seating in all of

these cases except for one, which was missing the gap. Cases in which the location of the gap was anterior could not be diagnosed by intraoperative radiographs, and were diagnosed postoperatively. Incomplete seating was seen in 3 of 9 cases that used a 2.8 mm shell thickness, and in 3 of 10 cases that used a 3.8 mm thickness. No case had complete dislocation or failure of the ceramic liner. There were no revision surgeries.

Discussions

Although there have been no published case reports regarding complete dislocation or failure of the ceramic liner caused by incomplete seating, adverse influences that are caused by incomplete seating remain uncertain. Some reports describe that incomplete seating was potentially attributed to poor exposure, bony and soft tissue impingement, and cup deformity. The attempt to avoid incomplete seating using intraoperative radiography was effective in cases where medial or lateral gaps were seen. However, it was ineffective in cases where gaps were anterior or posterior. Trident system ceramic liners need to be used with care to avoid incomplete seating.

Surgical Approach Affects Long Term Functional Outcomes in Gait After Receiving a Total Knee Arthroplasty

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Introduction

Minimally invasive, computer navigated techniques are gaining popularity for total knee replacement (TKA). While these techniques may have the potential to provide improved functional outcomes with more rapid recovery, little quantitative data exists comparing long-term gait function following surgery with different exposure approaches. This study compares functional gait differences between surgical approach groups two year following TKA. Kinetics, kinematics, and temporospatial parameters were assessed to determine if differences exist between groups in long term follow-up.

Methods

This study was approved by the Banner IRB (Sun Health Panel). 95 subjects volunteered to participate in the study and signed informed consent prior to testing. The subjects were prospectively randomized to one of four surgical approach groups, mini-midvastus (MV), mini-subvastus (SV), mini-parapatellar (MP), and standard parapatellar (SP). These subjects were also compared to 45 age-matched, asymptomatic controls. Surgery was performed by one of two fellowship trained orthopedic surgeons specializing in adult reconstruction. Subjects were assessed in the gait laboratory two years after receiving surgery. Three dimensional kinetic and kinematic data were captured using a ten-camera passive marker system, a modified Helen Hayes marker set (Eagle-4, Motion Analysis, Santa Rosa, CA), and four floor embedded force platforms (AMTI Inc., Watertown, MA). Subjects were instructed to walk at a self selected speed down an 8 meter walkway. Kinetic and kinematic data were post processed using EVaRT and OrthoTrak 6.23 biomechanical software (Motion Analysis, Santa Rosa, CA). Statistical analyses were performed using SPSS (v14.0, SPSS Inc, Chicago, IL) and included a one-way ANOVA and post hoc testing.

Results

50 subjects returned for a two year gait analysis. Selected results are provided in Table 1. All approach groups regained near normal knee function compared to age matched controls. Motion analysis provided specific statistical differences between parameters about the knee and hip. The MV approach group maintained greater flexion than other groups at the knee and hip throughout the gait cycle. The MP group maintained the most extended knee postures throughout the task with significant differences from controls being noted during peak flexion in swing ($p = 0.039$) and at foot strike ($p = 0.034$). They also had reduced external knee rotation angles ($p = 0.010$) and a larger pelvic rotation range of motion ($p = 0.020$). Although not significant, the MP group had a concurrent increase in pelvic obliquity on the operative limb during weight acceptance. The MP group also had the highest velocity, cadence, stride length, and the earliest toe off when compared to other groups.

Discussion

The results indicate that there are subtle differences in gait strategy between approach groups at the two year time point. The MV group maintains increased flexion angles at the hip and knee throughout the gait cycle which could

be characterized as a “bent-hip bent-knee” gait. This could be due to differences in capsular and muscle scarring between the different surgical approach groups. The MP approach group maintained more extended knee postures with improved velocity, cadence, and stride length. No differences in pain were detected in clinical scores.

Figures

2B : Patient management: #952 September 21st, 2011, 11:15-12:05

New Rehabilitation Device Increases Patient Ambulation Following Total Knee Replacement

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Introduction

The current standard of care for postoperative support during ambulation is a walker and accompanying gait belt. The use of a walker necessitates awkward body positioning, adequate upper body strength, and prohibits natural foot over foot progression during gait. Additionally, use of a gait belt necessitates that the therapist remains immediately beside or behind the patient, limiting the view of the patient's gait pattern and placing the therapist and patient at risk should the patient fall. The Secure Tracks™ (Fig 1) is a patient support device which runs in an overhead track and supports the patient in the periaxillary region, providing a more natural body position and foot progression while limiting the risk of falls. This prospective randomized study compares the rate of ambulation and other clinical outcomes measures in a population of total knee replacement recipients postoperatively.

Methods

A total of 31 unilateral total knee recipients were enrolled in this prospective randomized comparison between the standard of care gait training and the Secure Tracks device. IRB approval was obtained from the relevant oversight board. Patients were permitted to weight-bear as tolerated starting the evening of their surgical procedure. Patients were instructed to walk until they felt fatigued or unsafe and were not encouraged or discouraged to stop. The therapists tracked the distance each patient walked during each of their ambulation sessions and also recorded any incidence of falls or other adverse events. A timed up and go test (TUG) and Visual Analogue Scale for pain (VAS) were also administered at the time of consent, at discharge from the hospital, and at the 2 week clinic followup appointment.

Results

The mean distance walked by each rehabilitation group at all time points can be found In Table 1. On average, Secure Tracks patients walk between 52% and 152% further in each ambulation session. This amounted to a statistically significant increase on the day of surgery ($p=0.021$) and the second evening postop ($p=0.018$). The total distance walked while in the hospital was 96% greater in the Secure Tracks group (2,174 ft), compared to the standard rehabilitation group (1,170 ft) $p = 0.035$.

The results of the timed up and go test are contained In Table 2. Patients in the Secure Tracks group experienced significantly less pain during the TUG test at 2 weeks postoperatively ($p = 0.049$) and showed a trend to complete the task 3 seconds faster ($p = 0.11$). There was no statistically significant difference between the time required to complete the task, or the pain level experienced during the task, preoperatively or at discharge.

Discussion and Conclusion

The Secure Tracks proved to be a safe and effective patient support device that significantly increased the distance that patients walked during the postoperative period. The increased ambulation immediately following surgery likely contributed to the increased speed and decreased pain during the timed up and go test two weeks postoperatively.

Figures

7A : MIS - UNI knee: #772 September 22nd, 2011, 11:15-12:05

Femur Preparation for UKR Using Precision Freehand Sculpting

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Introduction

Precision Freehand Sculpting(PFS), is a hand-held semi-active robotic technology for bone shaping that works within the surgical navigation framework. PFS can alternate between two control modes – one based on control of exposure of the cutting bur ("Exposure Control") and another based on the control of the speed of the cutting bur ("Speed Control"). In this study we evaluate the performance of PFS in preparing the femoral bone surface for unicondylar knee replacement (UKR).

Methods

The experiment is designed to prepare a synthetic bone for unicondylar knee replacement (UKR). The implant plan is mapped to individual specimen using a jig that fit in a unique and repeatable way to all specimens. During bone preparation, the PFS handpiece and the specimen are both tracked with the Polaris Spectra (Northern Digital Inc.) using passive reflective markers. The cutting plan is specified so that the specimens can receive a specially designed implant after the cut is finished. The implant is a modified commercial design with three planar back faces and two pegs. In addition there are 10 conical divots on the implant surface that can be used to register the implant after it is placed on the prepared bone surface. The distal and distal-anterior facets were cut with a 5 mm cylindrical bur using Extension Control. The posterior facet and the post holes were cut using 6 mm spherical bur using Speed Control.

Three subjects cut 5 specimens each. One subject was an experienced PFS user. The second user was somewhat less experienced, and the third user was completely inexperienced with the use of PFS. The performance was evaluated in terms of the implant fit and the performance time. The final implant fit was characterized using a MicroScribe MX desktop coordinate measuring arm.

Results

The average cut times for the first two cuts combined were 4:45 min, and for the posterior cut 3:26 min. The average distances/st.dev. from the planned implant position were 0.54 /0.23 mm and the angular differences were average/st.dev. of 1.08/ 0.53 degrees.

Conclusions

All specimens were cut accurately, and with clinically acceptable surface finish. No implants were significantly malpositioned, nor were any unable to be positioned due to poor fit or planar malalignment.
For both experienced users, the procedure times were short, averaging below 8 min, whereas the inexperienced user demonstrated rapid improvement in performance time.

9B : Short stems: #418 September 22nd, 2011, 14:55-15:45

Stability and Strain Distribution for a New Conservative Hip Prosthesis: A Bone Preserving Option for the Younger Patient

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Introduction.

A new conservative hip stem has been designed to address the complex problem of total hip arthroplasty in the younger population.

Objectives.

To assess the stability and strain distribution of a new conservative hip stem.

Materials and Methods.

The prosthesis is tapered and collared and made from titanium (Ti6Al4V) with a titanium porous plasma spray to encourage bony ingrowth (Figure.1). It is circular-trapezoidal in cross-section to provide optimal 'fit and fill' in the femoral neck.

(i) Finite Element Analysis (FEA)

Computed tomography scans of an intact femur were modelled using MARC software and consisted of 161390 elements and 174881 nodes. The implant was modelled (Unigraphics) as a titanium alloy stem with a cobalt-chrome alloy head and consisted of 93440 hexahedral elements and 101133 nodes.

This study compared the strains in the femoral calcar of an intact femur with a stem 'implanted' in neck shaft angles of 125°, 135°, and 145°. The head of all models received a load of 2.3KN at 7 degrees medially.

(ii) Photoelastic Coating

A photoelastic coating was moulded around the medial cortices of ten third generation femora Sawbones. Strain before and after prosthesis insertion was measured at one-centimetre intervals down the medial cortex of the bones using a polariscope. The bones were positioned in a simplified single leg stance (7° physiological alignment), and loaded at 2.3 KN with strain recorded.

(iii) Linear Variable Differential Transducers (LVDT's)

Micromotion and migration of the prosthesis was measured using LVDT's. The femoral heads were cyclically loaded with 2.3KN at 1Hz for 2,500 cycles and held in a single leg stance. The bones were then repositioned at 70° of flexion to produce torsional (stair climbing) forces and loaded with 0.5KN for 2,500 cycles.

Statistical analysis of non-parametric data was performed using a two-tailed Wilcox signed rank test ($p<0.05$).

Results.

The FEA analysis revealed strains in the neutral position most closely resembled that of an intact femur (Figure.2). Photoelastic strain readings for intact bone and following insertion were paired and statistically analysed using the Wilcox signed rank test (two tailed). The composite bones with prostheses inserted at 125° and 145° demonstrated a significant difference to the intact bones, whereas those at 135° showed no significant difference in the surface strain pattern of the femur following prosthetic insertion (Figure.3).

Under single leg stance loading all prostheses produced axial micromotion of less than 200 μm and 50 μm in the varus-valgus direction. Implants inserted at 135° and 125° produced the least micromotion, the implants inserted at 145° had the greatest magnitude of motion and may be more susceptible to loosening. Under torsional load the same was true with the 135° and 125° producing the least micromotion while with the angulation of 145° micromotion increased over the test period – again suggesting loosening.

Conclusion.

This design transfers load in a physiological manner and the prosthesis is most stable in the neutral position. The findings from this study have been translated into clinical practice with the prosthesis implanted into two patients with promising results.

Figures

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Figure 1 HYPERLINK "http://app.istaonline.org/figures/369.jpg" \t "_blank"
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Figure 3

Surgical Navigation Strikes Back

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Surgical navigation in joint replacement has been developed for more than 10 years. After the initial enthusiastic period, it appears that few surgeons have included this technology into their routine practice. The reasons for this backflow are lack of evidence of any clinical superiority for navigation implanted prostheses, higher costs and longer operative time. However, navigation systems have evolved, and might still belong to the future of joint replacement.

Although most studies did not observe clinically relevant differences between navigated and conventional joint replacement, some registry studies identified significant advantages in favor of navigation: less blood loss, less early revision, subtle but relevant functional improvement… If TKR may be more forgiving, there is a trend to use less invasive implants (UKR), which are technically more demanding and may benefit from navigation. Ligamentous balancing may be more accurate and more reproducible with the help of navigation, and in that way patient specific templates may benefit from navigation. New techniques (short stem hip implants, hip resurfacing) have a relevant learning curve which may be fastened with navigation support.

Another key point may be the individual joint reconstruction: anatomy is different from one patient to the other, and navigation may help detecting these subtle differences to adapt a more physiological joint reconstruction, instead reconstructing all joints on the same model.

New navigation systems now available are designed in a more user-friendly style, with more straightforward workflow, and may be adapted to every surgeon's need.

Finally, navigation system may act as documentation and quality control system for health care providers, as well as a very powerful research tool for scientists and manufacturers.

7A : MIS - UNI knee: #1006 September 22nd, 2011, 11:15-12:05

Robot Assisted Unicompartmenal Knee Arthroplasty: Outcomes of 500 Consecutive Procedures

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INTRODUCTION

Unicompartmental knee arthroplasty (UKA) allows replacement of a single compartment in patients who have isolated osteoarthritis as a minimally invasive procedure. However, limited visualization of the surgical site provides challenges in ensuring accurate alignment and placement of the prosthesis.

With robot-assisted surgery, correct implant positioning and ligament balancing are obtainable with increased accuracy. To date, there has not been a large series reported in the literature of UKAs performed with robotic assistance. The aim of this study was to examine the clinical outcomes of robot-assisted UKA patients.

METHODS

510 patients who underwent robotic-assisted UKA between July 2008 and June 2010 were identified (average age 63.7 years, range: 22 to 28 years). Clinical outcomes were evaluated using the Oxford Knee Score (OKS) and patients without recent follow-up were phoned. Revision rate and time to revision were also examined.

RESULTS

Average length of stay was 1.4 days (range: 1 to 7 days). There was minimal blood loss with most procedures. There were two intra-operative complications, both in early patients in the series. The first intra-operative complication was broken alignment pins in both the femur and tibia. In the second complication, preparation was finished manually with a burr due to registration problems with the software. Both patients were doing well at

most recent follow up and neither experienced further complications.

At latest clinical follow-up, patients reported a mean OKS of 36.1 + 9.92. The revision rate was 2.5% with 13 patients either converted from an inlay to onlay prosthesis or conversion to TKA. The most common indication for revision was tibial component loosening, followed by progression of arthritis. One patient was revised due to infection. Mean time to revision was 9.55 + 5.48 months (range: 1 to 19 months).

CONCLUSION

UKA with a robotic system provides good pain relief and functional outcomes at short-term follow-up. Ensuring correct component alignment and ligament balancing increases the probability of a favorable outcome. Proper patient selection for appropriate UKA candidates remains an important factor for successful outcomes. In combination with robotic assistance there can be a reduction in many of the failures seen with early systems.

Pleanary session 1 : The future of TKA: #1140 September 21st, 2011, 9:45-10:30

Robotics: When the Surgeon Will Be Obsolete

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Abstract not available

8B : Bearings - hip: #883 September 22nd, 2011, 13:55-14:45

Early in Vivo Failure of 36mm Ceramic-on-Metal Hip Prostheses

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Introduction

Total hip prostheses which use a ceramic head within a metal liner are a relatively recent innovation. As such, survivorship rates from independent centres alongside explant analysis are rare. The early clinical experience with this novel ceramic-on-metal (CoM) bearing couple is reported alongside explant analysis of failed devices.

Methods and materials

All CoM hips implanted between 2008 and 2009 at a single hospital by a single surgeon were reviewed. Radiographs were analysed using EBRA software to determine acetabular cup inclination and anteversion angles. Blood metal ion concentrations were measured using inductively coupled plasma mass spectroscopy (ICPMS). Explants were measured for bearing surface and taper wear using a high precision co-ordinate measuring machine (Mitutoyo Legex 322, manufacturer's claimed accuracy 0.8μm). The roughness of the articulating surfaces of heads and liners was measured with a non-contact profilometer (ZYGO NewView 5000, 1nm resolution).

Results

In 56 patients 56 CoM hips were implanted. Mean (range) age was 64 years (34-87). There were 41 females and 15 males. Patients were followed-up for a mean of 1.5 years. Three hips were revised at mean of 1.2 years (2 female, 1 male) with a further 3 listed for revision under 1.5 years giving an overall failure rate of 10.7%. All these patients reported with pain. X-rays of failed devices showed a characteristic pattern of femoral stem loosening. Serum cobalt and chromium were less than 2 micrograms/L. Explant analysis of the three revised hips showed wear at the liner rim in each case. In two of these cases the wear extended completely around the circumference. The wear volumes were 4.1, 2.0 and 2.3mm^3 respectively. The ceramic heads were unworn but some transfer of metal could be seen visually. There was no significant wear or deformation at the taper junctions. Typical ceramic head roughness values were 3nm Ra and so most of the surface area of the heads remained in a pristine condition.

Discussion

The high early failure rate using a COM articulation is concerning. Explant analysis suggests equatorial contacts with propagation of high frictional forces distally. These forces may have caused early loosening of the femoral

stems. Orthopaedic surgeons and bioengineers need to be aware of this new mechanism of failure in this novel biomaterial coupling which is associated with low metal ions.

Minimum 5 Year Results of Cementation of a Metal-Inlay Polyethylene Liner Into a Stable Metal Shell in Revision Total Hip Arthroplasty

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Introduction:

This study was performed to evaluate the minimum 5-year clinical and radiological results of liner cementation into a stable acetabular shell using a metal-inlay, polyethylene liner during revision total hip arthroplasty (THA).

Methods:

Sixty-six hips (63 patients) that underwent revision THA using a metal-inlay polyethylene liner cementation were included. The causes of revision were; polyethylene wear in 37 cases, femoral stem loosening in 20 cases, ceramic head fracture in 4 cases, and recurrent dislocation in 5 cases. Clinical results were graded at final follow-up using Harris hip scores, and radiographs were evaluated to determine acetabular component inclination, the stabilities of acetabular and femoral components, correction of hip centers, and the progression of osteolysis.

Results:

The average follow-up was 87.3 months (range 60.1~134.3). Mean Harris hip scores improved from 64 preoperatively to 87.6 at final follow-up. Seven cases (10.6%) of dislocations occurred after revision surgery and 2 cases (3.0%) underwent acetabular revision or soft tissue augmentation. One cemented liner (1.5%) was dislodged and acetabular revision was performed using an acetabular reinforcement ring and a morselized bone graft. Two cases (3.0%) developed an infection and both underwent debridement and prosthesis with antibiotic-loaded acrylic cement (PROSTALAC) and intravenous antibiotics. Radiographic evaluations revealed osteolytic progression in the acetabular cup in 3 cases and osteolytic progression at the femoral stem in 7 cases, but none of these 10 cases underwent revision of the acetabular or femoral component. No cases of metallosis, metallic hypersensitivity, or cancer were encountered.

Conclusion:

This study shows that liner cementation into a stable metal shell provides relatively good clinical results. This technique offers lower surgical morbidity, a short operation time, and rapid patient recovery.

Summary:

Good clinical and radiologic outcomes were obtained at more than 5-years after liner cementation into a stable acetabular shell using a metal-inlay polyethylene liner during revision THA.

Metal Ion Release at the Taper Junction in Metal on Metal (MoM) Devices

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Introduction:

Ion analysis has been used as one of the key indicators to assess the performance of MoM devices in patients.

Modular devices, in particular having larger overall surface area (the stem and sleeve), and locking interfaces (head – bore, sleeve- taper and sleeve-bore, stem-taper surfaces) than other MoM devices are expected to release greater number of ions. Concerns have been expressed that the ion release at the taper junction might be a potential cause leading to the failure of the implant [Garbuz *et al*, 2010].

The aim of this study was to look into the wear and the associated ion release from the taper junction and the articulating surface of modular devices.

Method:

For the first time a novel design has been used to isolate the taper junction on modular devices on the hip simulators in order to compare the wear at the taper junction and articulating surface. The taper junction has been isolated in a small gaiter, while the head and cup were contained in a large gaiter. CoCrMo sleeves having an offset of +8 mm have been used on 50 mm modular heads along with Ti6Al4V stems. The acetabular components were standard BHR cups. Three devices (Smith & Nephew, UK) have been tested with newborn calf serum as a lubricant (in the large gaiter) and also as the medium containing the taper junction (in the small gaiter). The serum samples from the articulating surface and taper junction were analysed using HR-ICPMS. The locking interfaces at the taper junction have been left intact throughout the duration of the test. Both the head and the cup have been tested under anatomical conditions using the standard implant development centre's (IDC) profile for 2 million cycles (Mc). The lubricant was newborn calf serum with 0.2% sodium azide diluted with de-ionised water to achieve protein concentration of 20 mg/ml. The flexion/extension was 30°/15° and the internal/external rotation was ±10°. The force was Paul-type stance phase loading with a maximum load of 3 kN and a standard ISO swing phase load of 0.3 kN. The frequency was 1 Hz, with an 8 hour stop after every 16 hours of testing.

Results and discussion:

The ion analysis results from the articulating surface expressed in cumulative volume showed a biphasic wear trend at 0.96 ± 0.15 mm^3 (0.5 Mc) and 1.05 ± 0.13 mm^3 (2 Mc). The ion analysis results obtained for the samples from the small gaiter are $(1.83 \pm 0.35) \times 10^{-3}$ mm^3 at 0.5 Mc and $(4.52 \pm 0.83) \times 10^{-3}$ mm^3 (2 Mc). On comparison, the ion release from the taper junction is 100 fold lower than that from the articulating surface. It should be noted that the ion release from the taper junction can be influenced by the material, tolerance, surface finish and design of the taper joint.

Conclusion:

The ion release associated with the taper junction is extremely low when compared with the ion release from the articulating surface.

Reference:

Garbuz et al, CORR (2010) 468:318–325

1B : MIS - Hip: #472 September 21st, 2011, 8:30-9:35

Efficiency of the "Magic Tower" Device in Total Hip Arthroplasty Using the Direct Anterior Approach

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Introduction:

Total hip arthroplasty (THA) using the direct anterior approach (DAA) in a supine position is a minimally invasive surgery that reduces postoperative dislocation. Excellent exposure of both the acetabulum and proximal femoral part is important to reduce intraoperative complications. Generally, two surgical assistants need to hold four retractors to maintain excellent exposure of the acetabulum. We examined intra- and postoperative complications as indicators of the efficiency of using the "Magic Tower" (MT) device compared with a non-MT group.

Material and Method:

Twenty consecutive DAA THAs using MT were analyzed, and 20 DAA THAs not using MT were also analyzed. MT is a retractor-holding device, and has an arm structure that can be moved in a wide variety of directions. This device holds a retractor stably, and each movement of the arm can be locked by one click. Operating time, blood loss, length of skin incision, intraoperative complications, and number of assistants were

recorded. Postoperative radiographs were obtained to evaluate implant position.

Results:

Mean operating time was 105 min in the MT group and 118 min in the non-MT group. Mean blood loss was 232 g in the MT group and 233 g in the non-MT group. Mean length of skin incision was 80 mm in the MT group and 85 mm in the non-MT group. Mean cup inclination was 45.8° in the MT group and 47.3° in the non-MT group. Postoperative implant position was also excellent in both groups. In all comparisons, no significant differences were seen between groups. No intraoperative complications were encountered. Two assistants were required in the non-MT group, and one in the MT group.

Discussion:

A majority of the complications reported with THA can be attributed to access issues, i.e., difficulties in exposure and accurate component implantation. To achieve excellent exposure at the acetabulum, four retractors (anterior, posterior, cranial, and caudal) are desirable. In such procedures, two surgical assistants are needed to hold retractors. One of these assistants needs to hold the anterior retractor and cranial/caudal retractor from the opposite side of the surgery beyond the abdomen of the patient. However, the assistant on the opposite side cannot achieve good exposure, as strong retraction of the anterior part of the acetabulum may cause complications of femoral nerve palsy. The MT is able to hold a retractor firmly by applying pressure toward the acetabulum instead of traction, and also reduces the number of surgical assistants required. While preparing the femur, exposure of the femoral canal was also better than in the non-MT group.

Conclusion:

In primary DAA THA, no significant differences between groups were identified. However, the MT is clearly a useful device that allows maintenance of excellent exposure, reducing the number of surgical assistants required.

Figures

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Figure 3

13A : Robotics & navigation: #444 September 23rd, 2011, 11:15-12:05

Efficiency of the Complete Compass System for Identifying the Femoral Head Center in Total Knee Arthroplasty

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Introduction

Alignment and positioning of implants is important in total knee arthroplasty (TKA). Identifying the femoral hip center (FHC) without fluoroscopy or computer navigation is considered difficult. The Complete Compass system (CoCo) is a femoral extramedullary guidance system designed to identify the FHC. This apparatus provides an accurate representation of the femoral functional axis in the coronal plane without a computer navigation system. We compared postoperative implant alignment of patients undergoing total knee arthroplasty between CoCo and intraoperative computer navigation.

Materials and Methods

Twenty-five consecutive TKAs using CoCo were analyzed. CoCo has a pivotal arm with a pivotal shaft arranged to extend perpendicular to the coronal plane. A marker is attached to the pivotal arm to depict a circular arc on the marking plate with rotation of the pivotal arm. The pivotal shaft is placed at the intercondylar notch of the femur. The distance from the pivotal shaft to the marker is equal to the distance from the intercondylar notch of the femur to the FHC of the patient based on preoperative measurements in the coronal plane. This apparatus has a level of the horizontal plane and the condition of the pivotal shaft is able to match neutral positions in the sagittal and axial planes. The intersection of two arcs drawn by using CoCo with the hip joint in abduction and adduction indicates

the FHC position. Postoperative coronal and sagittal views radiographs were obtained. Twenty-five TKAs implanted using computer navigation were also analyzed for postoperative alignment. For two groups, targeted implant position was 90° in both planes for the femoral functional axis.

Results

In the CoCo group, mean absolute difference between planned and actual femoral placement was 0.5º (standard deviation (SD), 0.7) in the coronal plane and 2.8º (SD, 1.3) in the sagittal plane. For the computer navigation group, mean difference from ideal placement for the femur was 0.6º (SD, 0.7) in the coronal plane and 2.2º (SD, 1.4) in the sagittal plane. In all comparisons, no significant differences were seen between CoCo and computer navigation.

Conclusion

In this study, the Coco group achieved accurate alignment and implant positioning without computer navigation, and results were comparable to computer navigation TKA. CoCo is a simple system, and has the possibility to take the place of expensive computer navigation systems.

Figures

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Figure 1

Criteria for Cruciate Retaining or Posterior Substitute and Combination of Measured Resection Technique and Gap Technique in Total Knee Arthroplasty

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Introduction: Some authors have reported that if PCL is resected, flexion gap(FG) will become wider than extension gap(EG). Sacrifice or sparing of PCL influences the equality of EG and FG. Meanwhile, measured resection technique(MRT) and gap technique(GT) has different system to adjust gap and balance. There are no criteria for choosing between CR or PS component and MRT or GT nevertheless its influences on gap and balance in TKA.

Materials and Methods: EG and FG were measured intra-operatively with PCL intact to assess the characteristics of EG and FG. EG was created ordinarily. To measure FG before the final femoral cutting with PCL intact, small temporary FG was created by a pre-cut of the femoral posterior condyle with a 4-in-1 femoral cutting guide bigger than the measured size. After removal of all osteophytes, the gaps were measured by a tension device. To compare both gaps, FG was corrected by the amount of the pre-cut. According to EG and corrected FG, a component type was selected. If there was enough FG with PCL intact, CR component was implanted and if not, PS component was selected. If necessary, soft tissue was released. Finally, the optimal size of the femoral component for adequate EG and FG was estimated and rotation of the femoral component was decided. One hundred and fifty three knees with osteoarthritis were investigated.

Results: EG ranged from 8 to 29 (17.5±3.4) mm and corrected FG ranged from 10 to 31 (20.2±3.9) mm. The range of the difference between the two gaps was -4 to 12 (2.7±3.2) mm, and FG was significantly larger than EG. Based on the measured gaps, CR component was used in 118 knees and PS in only 35 knees. The gap increase by PCL resection ranged from 0 to 3 (0.5±0.7) mm in EG and from 0 to 7 (2.5±2.0) mm in FG. FG increase was significantly larger than EG increase. Gap balance in EG and FG were estimated in 131 knees before the final femoral cutting. Extension balance was 1.6±2.0 degree varus and flexion balance was 0.4±3.2 degree valgus on average. Finally, 114 knees were implanted without change of the femoral component rotation as MRT and the rotation was changed in 17 knees. Parallel cut to the tibial surface as GT was performed in 5 knees and the rotation was positioned between MRT and GT in 12 knees.

Discussion: Our results indicate that the selection of PS component in all cases would have resulted in a much larger FG in many cases. Given the wide variations in EG, FG, and FG increase, it would be difficult to use only

one component, CR or PS, in every case. To attain adequate gaps, better results are achieved by deciding which component to use, CR or PS, based on intra-operative gap measurement. With this technique, MRT and GT could be combined and the femoral component rotation could be decided freely at the final step of the surgery. There is no longer a necessity to distinguish MRT from GT.

: #908 , 0:00-0:00

Total Knee Arthroplasty Using the All-Polyethylene Tibial Component - Early Outcomes

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Objectives

All Polyethylene Tibial components in Total Knee Arthroplasty have been in use for some years, studies showing equivalent results to Total Knee Arthroplasty (TKA) with metal-backed Tibial components at 10 years have shown no significant difference between the two on radiostereometric analysis and revision rates[1].

Post operative patient outcome data using standard metal-backed Tibial components is widely reported in the literature. This study is looking at patient outcomes following All-polyethylene tibial component TKA. We hypothesize that using standard patient outcome measures, an improvement comparable with that expected for metal-backed tibial component TKA will be shown with All-polyethylene tibial component TKA.

Methods

Between August 2006 and August 2008, 229 all-polyethylene tibial component TKA were implanted at the elective orthopedic unit. The choice of implant was entirely dependent on surgeon's preference.

Of the 229 patient's, 225 details were available for review, 27 did not wish to take part in the study and 1 patient died a year following surgery of an unrelated illness. The remaining 197 patients agreed to take part in the study.

The patient's were contacted either in person or over the telephone and asked to completed questionnaires for standard knee scoring.

These included: the Oxford Knee Score (OKS), the WOMAC Score and the SF-12 Score, both pre-operatively and post operatively.

Results

All three Scoring systems used showed an overall improvement post-operatively, as would be reasonably be expected.

The results for the OKS, WOMAC and SF-12 all showed an improvement comparable with that expected for metal-backed tibial component TKA.

Conclusions

Total Knee Arthroplasty using an all-polyethylene tibial component has been shown with these early results to be a reasonable alternative to metal-backed options offering some advantages. [1,2]

References

Bettinson KA, Pinder IM, Moran CG, Weir DJ, Lingard EA: JBJS(Am) 2009;91:1587-1594.

Gioe TJ, Maheshwari AV: JBJS(Am) 2010;92:478-487.

1B : MIS - Hip: #847 September 21st, 2011, 8:30-9:35

Predicting Difficulty of Femoral Preparation Through Radiographic Analysis in Minimally Invasive Approach for Total Hip Arthroplasty.

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Introduction:

The advantages of the direct anterior approach (DAA) for total hip arthroplasty include the preservation of external rotators and hip abductors thus leading to quicker recovery times. To our knowledge, there is no objective method in the literature to predict the level of difficulty for femoral exposure through the DAA. It would be beneficial to the surgeon learning the DAA to assess difficulty pre-operatively to avoid prolonged operative times.. The purpose of this study was to develop a predictive model of femoral exposure difficulty in the DAA using a combination of demographic data and radiographic measurements.

Methods:

305 post-operative radiographs of consecutive THA's in patients (184 female, 120 male) with primary or secondary osteoarthritis, mean age 64.6 (range 26-91, SD=11.43) performed through the DAA by one of the co-investigators from 12/2005 to 12/2009 were retrospectively reviewed by two separate observers. The observers were blinded to the difficulty level of femoral exposure. Standard post-operative AP pelvis films were assessed with TraumaCad software (TraumaCad 2.2, Voyant Health, Columbia, MD) to make radiographic measurements as shown in Figure 1-2. Each radiograph was calibrated using the size of the femoral head implant. Exclusion criteria included films that had inadequate coverage of the entire pelvis, mal-rotation, or poor exposure. Statistical analysis was performed using STAT 9.1 (StatCorp; College Station, Texas, USA). A two-sided Kruskal–Wallis test was utilized for non-parametric data. Chi-squared tests and Fisher's Exact Test were used to compare proportions. Statistically significant associations were then added to a multivariate model predicting an outcome of difficult exposure.

Results:

The difficult exposures were equally distributed throughout the study period. The side of the THA was not associated with a difficult exposure (χ^2=0.5516, p=0..968) whereas 66% of difficult cases were male (χ^2=38.5323, p=0.0001). Height, weight, BMI, and age were all independent predictors of a difficult exposure, with taller (>175cm) more difficult than shorter (p=.0001), heavier (>100kg) more difficult than lighter (p=.0001), higher BMI (>32) being more difficult than lower BMI (p=.0001), and younger age (<60) being more difficult than older age (p=.003). Radiographic criteria that were predictive of difficult femoral preparation were decreased distance (<110mm) between teardrop signs (p=.0001), increased distance (>211mm) between each SLA (p=0.013), and increased distance (>306mm) between the GT (p=.007). The distance between each ASIS (p=0.375), ASIS to GT (p=.191), and ASIS to SLA (p=.191) were not predictive of difficult femoral preparations. From this, we determined a simple pre-operative scoring tool which allows the surgeon to predict difficult femoral preparations with an 87% sensitivity and easy preparations with >95% specificity.

Conclusion:

The DAA approach has proven difficult to learn for many surgeons. Careful patient selection can facilitate the learning curve and improve patient outcomes. We describe a simple to implement preoperative rating scale, which gives the surgeon learning DAA an algorithm for appropriate patient selection. Selecting the appropriate patient can reduce the risks to the patient and minimize the cost to society of integrating new surgical techniques.

Figures

15B : Bearing materials: #582 September 23rd, 2011, 14:50-15:40

Annealing Stabilizes Vitamin E Radicals and Accelerates Crosslinking Reaction in Electron-Beam-Irradiated Dl-Alpha-Tocopherol-Blended Ultra High Molecular Weight Polyethylene

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INTRODUCTION:

Electron-beam-irradiated *dl*-α-Tocopherol (Vitamin E)-blended UHMWPE is now being considered as a potential new bearing surface material for hip prosthesis [1]. However, Vitamin E stabilizes some of the primary free-radicals required for crosslinking, thereby reducing the material's crosslink density [2]. Additionally, some biological-stabilization effects of Vitamin E may also be reduced by oxidation. In this study, Vitamin E radicals in electron-beam-irradiated UHMWPE were measured and identified using Electron Spin Resonance (ESR), and the effects of annealing on radical stabilization and crosslink density were examined.

MATERIALS & METHODS:

Both pure UHMWPE and Vitamin E added (0.3% w/w) resin was used to produce bulk specimens via vacuum direct compression molding at 220°C under 25 MPa for 30 min. Cylindrical pins (3.5 mm diameter, 40 mm length) for ESR measurement were then machined and placed in vacuum packaging. The pins were irradiated at 300 kGy, with half of each test group annealed at 80°C for 24 hours. Free radical measurements were made using a high-sensitive X-band ESR operating at 9.44 GHz. Detection of Vitamin E radicals was performed by comparing the characteristic symmetrical spectrum of oxidized Vitamin E to the spectra observed for the pins using both g-value and linewidth as references. Crosslink density was measured via gel fraction analysis and was performed in accordance with ASTM D2765. Thin sections (20×40 mm^2, 200 μm) were machined from the bulk specimens, which were then placed in vacuum packaging, irradiated and annealed at the same conditions as those for the ESR measurements. Two of these thin sections were then placed in a stainless-steel cage (200 μm pore diameter) and were immersed in decahydronaphtalene at 200°C for 24 hours. These specimens were then extracted using soxhlet extractor at 100°C for 24 hours and dried in vacuum at 150°C for 12 hours.

RESULTS:

The characteristic symmetrical spectrum of oxidized Vitamin E was measured and identified in the electron-beam-irradiated Vitamin E-blended specimens [Fig. 1]. For the annealed samples, this spectrum was reduced [Fig. 2]. The annealing treatments increased gel fraction [Fig. 3] and decreased the total amount of primary free-radicals [Fig. 4] in the electron-beam-irradiated Vitamin E-blended specimens at the same rate as that for the Virgin specimens.

DISCUSSION & CONCLUSIONS:

Electron-beam-irradiated Vitamin E-blended specimens showed the same characteristic symmetrical spectrum as that of oxidized Vitamin E. Thus, measurement and identification of Vitamin E radicals in electron-beam-irradiated UHMWPE was confirmed. Also, annealing treatment at 80°C for 24 hours was effective in stabilizing Vitamin E radicals. The results showed in [Fig. 3] and [Fig. 4] suggest that the treatments increased gel fraction by accelerating the reaction between primary free-radicals. The results also suggest that Vitamin E radical stabilization was achieved through the interaction of Vitamin E radicals amongst themselves, and not through the interchange between Vitamin E radicals and primary free-radicals.

REFERENCES:

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ACKNOWLEDGEMENTS:

The authors wish to acknowledge K.Tajima at Kyoto Institute of Technology for technical support.

Figures

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Figure 4

Wear Performance of Modular and Metal-Backed Monoblock Components With Sequentially Crosslinked UHMWPE

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INTRODUCTION

For cementless TKA, highly crosslinked UHWMPE is traditionally used with modular components because of manufacturing and sterilization complexities of monoblock metal-backed components. However, it would be very useful to have a highly crosslinked UHMWPE monoblock metal-backed cementless component to address historical clinical issues. The purpose of this study was to evaluate the wear properties of a unique process for achieving a monoblock metal-backed cementless component featuring highly crosslinked polyethylene to standard highly crosslinked UHWMPE.

MATERIALS AND METHODS

The knee system used for testing consisted of cobalt chrome femoral components and tibial trays (Triathlon®, Stryker Orthopaedics, Mahwah, NJ). Modular tibial inserts were machined from GUR 1020 polyethylene that was irradiated to 30 kGy and annealed three times (Modular, n=5) (X3, Stryker Orthopaedics, Mahwah, NJ). Monoblock tibias were direct compression molded to a metal substrate and then irradiated to 30 kGy and annealed three times. For the purposes of this test, the polyethylene was removed from the monoblock component and machined into a standard tibial insert (Monoblock, n=5).

A 6-station knee simulator was utilized for testing (MTS, Eden Prairie, MN). All motion and loading was computer controlled and waveforms followed ISO 14243-3 [1]. Testing was conducted at a frequency of 1 Hz for 3 million cycles. The lubricant used was Alpha Calf Fraction serum (Hyclone Labs, Logan, UT) diluted to 50% with a pH-balanced 20-mMole solution of deionized water and EDTA [2]. The serum solution was replaced and inserts were weighed for gravimetric wear at least every 0.5 million cycles. Standard test protocols were used for cleaning, weighing and assessing the wear loss of the tibial inserts [3]. Soak control specimens were used to correct for fluid absorption with weight loss data converted to volumetric data (by material density). Statistical analysis was performed using the Student's t-test with significance determined at the 95% confidence level ($p < 0.05$).

RESULTS

The average volume loss and volumetric wear rates at 3 million cycles are represented in Figure 1 and Figure 2. Group 1: Highly Crosslinked UHMWPE had a wear rate of 2.8±0.6 mm^3/mc, where the Group 2: Monoblock Highly Crosslinked UHMWPE was 2.8±0.2 mm^3/mc. There was no statistical difference ($p = 0.95$).

CONCLUSION:

The results of testing show that the Monoblock Highly Crosslinked UHMWPE material is the same in wear performance relative to Modular Highly Crosslinked UHMWPE material. These results suggest that this new material may have applications in monoblock implant design applications but further testing for specific applications is needed.

References:

ISO/DIS 14243-3. – Implants for surgery –Wear of total knee joint prostheses – Part 3: Loading and displacement parameters for wear testing machines with displacement control and corresponding environmental conditions for test.

Wang, A., Essner, A., Schmidig, G., "The effects of lubricant Composition on *In Vitro* wear testing of polymeric acetabular components". *J. Biomed. Mater. Res. Part B: Appl Biomater* 68B: 45-52, 2004.

ASTM F2025 - Standard Practice for Gravimetric Measurement of Polymeric Components for Wear Assessment.

Figures

14A : Patella: #921 September 23rd, 2011, 13:50-14:40

The Effect of Mal-Aligned Conditions on Shear Forces on Patellar Components

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INTRODUCTION

Wear and fracture of patellar components has been frequently reported as a failure mode for cemented and press-fit patellar components. Malalignment of the patellar components may cause higher contact stresses, which may lead to excessive wear, delamination, and/or component fracture. *In vitro* testing of the patella in a clinically relevant malaligned condition is necessary to demonstrate adequate performance of the patellar component and assess the endurance of its fixation features under severe loading conditions. The purpose of this study was to test *in vitro* the patellar components under malaligned conditions using a knee joint simulator.

MATERIALS AND METHODS

A 6 station MTS (Eden Prairie, MN) knee joint wear simulator and Alpha Calf Fraction serum (Hyclone Labs, Logan, UT) diluted to 50% with a pH-balanced 20-mMole solution of deionized water and EDTA was used (protein level = 20 g/l) for testing. Asymmetric, all-polyethylene, patellar components with an overall construct thickness of 11 mm (Duracon®, Stryker Orthopaedics, Mahwah, NJ) were used. Appropriately sized cobalt-chrome femoral components articulated against the patellae.

The patellae were cemented (Simplex, Stryker Orthopaedics, Mahwah, NJ) to delrin fixtures, which placed the patella in 10° of lateral tilt (Figure 1). This angle was chosen based off the work of Huang et al, which was one of the larger average tilt angles reported *in vivo.* Replicating this scenario *in vitro* allows for observation of the potential scenario that may occur as the femoral component maintains contact strictly on the thinner lateral edge of the patella, concentrating both the axial and shear loads on a small area of polyethylene.

The loading and kinematic profiles used for testing were published previously (maximum axial load: 2450N and maximum patellofemoral angle: 54°. Variations of the loading profile were studied by evaluating the effects of heavier patients, which increased the maximum axial load to 3100N(250lb patient) and 3750N(300lb patient) (Figure 2). Lateral offset was tested to evaluate the effect of malalignment. Increments of 1mm were analyzed starting from the neutral position, eventually reaching a maximum lateral offset of 5mm.

A 6-dof load cell was placed beneath the patella fixturing to capture dynamic loads (ATI, Apex, NC). The axial and medial/lateral shear loads where used to calculate the resultant medial/lateral shear force being applied to the patellar pegs.

RESULTS

The results of using a heavier loading profile and increasing lateral offset are shown in Figure 3. At neutral alignment, the effect of increasing the axial load caused an increase of 10% in resultant shear force. At 5 mm of lateral offset, the increase in loading caused the shear force to increase by 16%. With each loading profile, increasing the lateral offset from 0 to 5 mm caused the resultant shear force to increase two-fold.

DISCUSSION

This test model allows for an aggressive method of testing patellar implants and it includes variables to adjust for severity (lateral offset and joint reaction force). Although increasing the amount of lateral patellar offset increases the resultant shear forces, the patellar wear rates remained minimal and constant. Hence, a femoral component that has a forgiving patellar tracking may demonstrate minimal wear, even when evaluated in extremely aggressive test conditions. Note: These results are specific to the device used since the results will be dependent on the function and design of the patellar implant and patella/femur track.

Figures

10B : Bearings - hip: #620 September 22nd, 2011, 16:40-17:30

Long-Term Survivorship and Wear Rates of Ceramic and Metal Femoral Heads on Conventional Polyethylene in Young Patients: A Matched Pair Analysis

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Introduction:

Ceramic femoral heads have proven to be more scratch resistant with better wettability and improved wear characteristics compared to metal heads in the laboratory setting. The objective of this study was to compare long-term survivorship and in vivo wear rates of ceramic and metal femoral heads against conventional polyethylene articulation in young patients.

Materials and Methods:

Thirty-one matched pair of alumina and metal femoral heads against conventional polyethylene in young patients (≤ 65 years) were analyzed for wear and failures for mechanical reasons. The match was based on gender and age at the time of surgery. All procedures were performed between June 1989 and May 1992 by a single surgeon via posterolateral approach, using non-cemented RB (Ranawat-Bernstein) stems, HG II (Harris-Galante) cups, 4150 conventional polyethylene and 28mm femoral heads.

Hospital for Special Surgery (HSS) hip score was used for clinical analysis. Wear measurements were performed between the initial anteroposterior standing pelvis radiographs, at a minimum of one year after the index procedure to eliminate the effect of bedding-in period, and the latest follow-up. Two independent observers analyzed polyethylene wear rates using the computer-assisted Roman 1.70 software. In revision cases, the wear rates were calculated from radiographs prior to revision surgery. A pair student t test was performed to analyze the statistical difference. Two-tailed ϱ values less than 0.05 were considered statistically significant.

Results:

The mean age was 54.5 ± 8.5 at the time of surgery (range 23.3 – 65). Average clinical and radiographic follow-up were 17 ± 2.1 (range 12.8 – 20) and 14.1 ± 2.6 years (range 10 – 19.1) respectively. The mean HSS score in ceramic and metal groups were 30.4 ± 8 (range 24 - 56) and 36.6 ± 4.7 (range 20 - 40) respectively. The mean wear rate for the ceramic group and the metal group were 0.086 ± 0.046 mm/year and 0.137 ± 0.052 mm/year, respectively which was statistically significant ($p < 0.001$). There were no revisions in the ceramic group for osteolysis or loosening, however one patient required a strut graft for femoral osteolysis that was distal to the tip of the implant due to non-circumferential porous coating of the stem. There were 3 cup revisions in the metal group, all for acetabular osteolysis, and no stem lysis or loosening. The Kaplan-Meier survivorship for revision for mechanical failure in the ceramic and metal group was 100% and 90.3% respectively.

Discussion:

The low mean wear rate of ceramic compared to metal in this study is consistent with previously published laboratory reports. There was no revision for loosening or osteolysis in the ceramic group, with 100% survivorship for revision due to mechanical failures, which demonstrates superior durability of this material compared to metal femoral heads. The strength of this study is that this the first long-term report comparing ceramic and metal femoral heads against conventional polyethylene using a matched pair analysis in young patients.

12B : Hip arthroplasty: #616 September 23rd, 2011, 8:30-9:35

Change in Pelvic Tilt After Total Hip Arthoplasty

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Introduction:

The optimal goal for cup positioning in hip arthroplasty in individual patients is affected by many factors including surgical exposure, femoral anteversion, and pelvic tilt. Some navigation systems ignore pelvic tilt and are based strictly on the anterior pelvic plane while others incorporate pelvic tilt, as measured in the supine position on the operating table. Neither approach incorporates knowledge of preoperative spino-pelvic flexibility or predictions of the change in spino-pelvic attitude or flexibility following surgery. While prior studies have shown little change in pelvic tilt postoperatively, one recent study based on gait analysis, suggested that changes in pelvic tilt are not predictable. The current study aims to assess changes in pelvic tilt following surgery.

Methods:

24 patients, 12 male and 12 female, underwent THA using CT-based navigation. Each patient had supine and standing AP pelvis radiographs both pre-operatively and at a minimum of 1 year post-operatively. Pelvic tilt on each radiograph was measured using a noncommercial two-dimensional/three-dimensional matching application. (HipMatch; Institut for Surgical Technology and Biomechanics, Bern, Switzerland). This software application uses a fully auto- mated registration procedure that can match the three- dimensional model of the preoperative CT with the projected pelvis on a postoperative radiograph. This method has been validated and for measurement of cup position for example showed a mean accuracy of 1.7° +/- 1.7° (rang-4.6° to 5.5°) in the coronal plane and 0.9° +/- 2.8° (rang-5.2° to 5.7°) in the sagittal plane compared with postoperative CT measurements. The software showed a good consistency with an intraclass correlation coefficient (ICC) for inclination of 0.96 (95% confidence interval [CI]: 0.93 to 0.98) and for anteversion of 0.95 (95% CI: 0.91 to 0.98). A good reproducibility and reliability for both inclination and anteversion was found with an ICC ranging from 0.95 to 0.99. No systematic errors in accuracy were detected with the Bland- Altman analysis. Using the HipMatch 2D/3D application, changes in pelvic tilt before and after surgery were assess in both the supine and standing positions.

Results:

Preoperatively, the mean standing pelvic tilt was .9 degrees (range 10.9 to -9.2) and the mean supine pelvic tilt was 3.7 degrees (range 11.8 to -7.7). Postoperatively, the mean standing pelvic tilt was 1.1 degrees (range 13.8 to -12.3) and the mean supine pelvic tilt was 5.9 degrees (-4.0 to 16.5). The maximum change following surgery in individual patients was -4.9 degrees standing and -8.5 degrees supine. Pre-operative supine pelvic tilt predicts post-operative supine pelvic tilt with an r^2 of .67. Pre-operative standing pelvic tilt predicts post-operative standing pelvic tilt with an r^2 of 0.91.

Discussion:

Overall, in both the standing and supine positions, pelvic tilt changed very little as a result of total hip arthroplasty in this sample of patients and pre-operative pelvic tilt is clearly predictive of post-operative pelvic tilt. Preoperative assessment of pelvic tilt, as measured either in the supine or standing position, may be useful information when determining optimal cup positioning goals for total hip arthroplasty. We recommend that both preoperative assessment of pelvic tilt and preoperative or intraoperative assessment of femoral anteversion should be considered when determining optimal acetabular component positioning.

13A : Robotics & navigation: #987 September 23rd, 2011, 11:15-12:05

Total Knee Arthroplasty With a Robotic Cutting Guide - a Retrospective Study Assessing Accuracy and Surgical Time.

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Introduction:

Robotic-guided arthroplasty procedures are becoming increasingly common, though to our knowledge there are no published studies on robotic cutting guides in TKA. We introduced a new computer-navigated TKA system with a

robotic cutting-guide into a community-based hospital and characterized the accuracy and efficiency of the technique with respect to bone cutting, component alignment and final limb alignment, and tourniquet time.

Methods:

The first 100 cases from a single-surgeon were retrospectively reviewed following IRB approval. Intra-operative bone-cut accuracy and overall limb alignment as measured by the computer were collected and divided into consecutive quartiles: Group I, cases 1-25; Group II, cases 26-50; Group III, cases 51-74; Group IV, cases 75-100. All resections were planned neutral to the mechanical axis. Postoperative component alignment and the overall mechanical axis limb alignment in the coronal plane were also measured on standing long-leg AP radiographs by two independent observers at a minimum six weeks post-op. This mechanical radiographic alignment was available for 62 cases. Tourniquet time (the time prior to incision until after cementation) and robotic cutting guide use time were also analyzed.

Results:

Intra-operative Computer Data: Bone-cut accuracy was a mean 0.1° valgus, SD±0.8° for both the femur and tibia (range, femur: 2.0° valgus to 1.5° varus; range, tibia: 3.5° valgus to 1.5° varus). Final limb alignment was within 3° of neutral for 98% (96/98) of cases (range: 2.0° valgus to 3.5° varus).

Radiographic Alignment Data: Pre-operative mechanical alignment ranged from -14.5° valgus to 21.5° varus. Radiographic femoral and tibial component alignment was within 3° of neutral in 98.4% of cases (61/62). Final limb alignment was within 3° of neutral for 87.1% (54/62) of cases (range: 4.5° varus to 4.5° valgus).

Learning curve: Mean tourniquet time was 10 minutes longer for Group I (60 minutes ± 9.9SD, range 46-79) than for groups II, III, and IV (average mean 49.5min, range 35-68), $p=0.0001$. Within Group I, mean tourniquet time for the first ten and second ten procedures was 65 ± 10.6 min and 55 ± 8.3 min, respectively, $p=0.034$. Robotic-guide use time was also longer for the first quartile (7.8 ± 1.9 minutes, range 4-12), than for Groups II, III, and IV (average 5.2 minutes, range, 3-8), $p<0.001$. There were no significant differences in any of the accuracy measures among the different groups ($p>0.05$).

Conclusion:

Imageless computer-navigated TKA with a robotic cutting guide allowed one surgeon to make bone resections within 3° of neutral in 98% of cases. Radiographic limb alignment was less precise, which is consistent with the known limitations inherent to this measurement technique. During the learning curve phase, surgeons can expect the procedure to take an average of 15 extra minutes during the first ten cases and 5 extra minutes during the second ten without compromising accuracy.

Pleanary session 1 : The future of TKA: #1079 September 21st, 2011, 9:45-10:30

TKA Mechanics: What Does the Future Hold ?

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TKA Mechanics: What Does the Future Hold ?

1A : Kinematics and Wear-knee: #1102 September 21st, 2011, 8:30-9:35

IN VIVO MECHANICS of TKA: Kinematics, Kinetics and Sound

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INTRODUCTION

Multiple video fluoroscopic analyses have been performed to determine the in vivo kinematic patterns of total knee arthroplasty (TKA) and non implanted knees. Unfortunately, many of these studies were not correlated with bearing surface forces and possible failure modes that could be detected with a sound sensor. Therefore, the objective of the present study was to conduct a comparative analysis of the kinematic data derived for all subjects having a TKA who were analyzed over the past seventeen years at our laboratory and to determine how these patterns correlate with bearing surface forces and joint sound.

METHODS

Initially, femorotibial contact positions and axial rotation magnitudes were derived for subjects having either a non implanted or implanted knee. Non implanted knees consisted of normal and anterior cruciate ligament (ACL) deficient knees (ACLD). Implanted knees consisted of posterior stabilized (PS) fixed (PSF) and mobile (PSM) bearing, posterior cruciate ligament retaining (PCR) fixed (PCRF) and mobile (PCRM) bearing, posterior cruciate sacrificing mobile (PCSM) bearing and ACL retaining fixed (ACRF) bearing TKA. Each subject, while under fluoroscopic surveillance, performed a weight-bearing deep knee bend and/or normal gait. Using a three-dimensional (3D) model fitting approach, the relative pose of knee implant components were determined in 3D from a single-perspective fluoroscopic image by manipulating a CAD model in three-dimensional space. Anterior/posterior (A/P) contact positions for both the medial and lateral condyles and axial rotation of the femoral component relative to the tibial component were assessed. Then, a subset of these subjects were further analyzed to determine their in vivo bearing surface forces and joint sound using a more recently derived protocol for analyzing audible signals.

RESULTS

During gait, subjects having a ACRF TKA experienced the most normal-like kinematic patterns, where the femoral condyles were more anterior than other TKA designs. Subjects having a PCSM TKA experienced the least amount of femoral head sliding during gait, whereas the medial and lateral condyles remained near the midline of the tibia in the sagittal plane. Subjects having a mobile bearing TKA did seem to experience axial rotation during this activity. Subjects having a normal knee experienced posterior motion of the lateral condyle from full extension to maximum knee flexion (maximum = 27 mm), while their medial condyle experienced less motion (maximum 12 mm). Similar to the subjects with a normal knee, all subjects having an ACRF TKA experienced posterior motion of their lateral condyle, albeit less than the normal knee, and less medial condyle motion. Subjects having a PCRF or PCRM TKA experienced highly variable kinematic patterns. Many of these subjects experienced an anterior sliding motion with increasing knee flexion. Subjects having either a PSF or PSM TKA experienced a higher incidence and magnitude of posterior condylar motion, but less in magnitude when compared with the normal knee. Not all PS TKA knees produced similar results and some experienced poor weight-bearing range-of-motion and more erratic kinematic patterns. Subjects having a PCSM TKA experienced a contact position that remained centralized during the deep knee bend activity, often leading to posterior impingement and less weight-bearing range-of-motion. Subjects having a mobile bearing TKA experienced greater contact area and less contact stress than subjects having a fixed bearing TKA and subjects having a high flexion TKA experienced less contact stress in deep flexion than subjects having a more traditional-type TKA design. The sound sensor revealed various sounds related to cam/post mechanism engagement, condylar lift-off, patellofemoral interaction and other sounds that at present, having not yet been correlated to identifiable mechanics parameters.

DISCUSSION

The magnitudes of posterior femoral rollback during deep flexion in all TKA designs tested were less than in the normal knee. This may explain, at least in part, why knee flexion following TKA is reduced when compared to the normal knee. During gait, PSF and PSM TKA designs experienced similar kinematic patterns as those designs that lacked a cam and post mechanism. Subjects having a TKA experienced significantly less axial rotation when compared to the normal knee ($p<0.001$). Reversing axial rotation patterns where of high incidence in subjects having a TKA. Additionally, it is clear that surgeon variability can play a significant role in eventual knee mechanics patterns. Bearing surface mechanics related to contact force, area and stress varied considerably between subjects and TKA designs. Bearing surface sounds may play a significant role in the future when attempting to assess failure modes as various sounds were detected for subjects having a TKA design.

1A : Kinematics and Wear-knee: #474 September 21st, 2011, 8:30-9:35

Wear in Total Knee Arthroplasty - Just a Question of Polyethylene?

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Introduction:

Failure of total knee arthroplasty (TKA) is mainly caused by biological reactions against wear particles generated at the implant. So far, wear has been mainly attributed to polyethylene (PE) and much effort has been put into understanding and optimizing the wear mechanism of PE in recent years. However, evaluation of metal wear particles and ion release in TKR has been neglected so far although the implants present large metal surface areas. In the present study we aimed to analyse the wear performance of TKA and to study the kinetics of metal ion and particle release. We hypnotized that due to abrasion and corrosion TKA will release relevant levels of Cobalt (Co), Chromium (Cr), Molybdenum (Mo) and Titanium (Ti).

Methods:

Implants were subjected to an in-vitro simulation applying physiological loadings and motions for 5 million walking cycles. Wear processes were determined gravimetrically and by measuring the release of Co, Cr, Mo and Ti ions using HR-ICP-MS. Surface alterations were determined through surface roughness measurements.

Results:

An average PE wear rate of 7.28 mg/10^6 cycles ($R=0.995;p\leq0.001$) was determined

After 5 million cycles the cumulative release of metals measured 1.63 ± 0.28mg for Co, 0.47 ± 0.06mg for Cr, 0.42 ± 0.06 mg for Mo and 1.28 ± 0.14mg for Ti. The metal release progressed linearly and the rate of sole surface corrosion was 0.06mg/10^6 cycles ($R=0.993;p\leq0.001$), whereas the rate of articulation induced metal release was found to be 0.80mg/10^6 cycles ($R=0.996;p\leq0.001$), (Fig. 1).

Discussion:

For other metallic implant devices it is well known that metal wear products are able to interact with the immune system potentially leading to immunotoxic effects like hypersersensitivity or the formation of pseudotumors. To our knowledge, this is the first study that analysed the release of metallic wear products in TKA in vitro. We found that approx. 10% of the whole wear products are metallic and we believe that these particles and ions are relevant. Their effect regarding the clinical outcome of TKR will be analysed in further studies.

Figures

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Figure 1

Major and Minor Complications Following Minimally Invasive Anterior Approach With Fracture Table for Total Hip Arthroplasty

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Introduction:

The anterior approach to primary total hip arthroplasty is an unfamiliar approach to most surgeons that is considered to be minimally invasive based on the premise that there is less soft tissue damage and quicker post-operative recovery time. We present our experience of using the anterior approach exclusively by a single surgeon at multiple surgical centers for a period of 3.5 years.

Method:

709 consecutive patients undergoing primary hip arthroplasties from 8/2007 to 12/2010 through a direct anterior approach were performed by single surgeon with extensive training in the approach. The procedure was performed with the patient supine on a fracture table (Trumph arch table extension) through an anterior approach as described by Dr. Joel Matta through a Smith-Peterson interval. Intra-operative data and complications were collected prospectively and to avoid missing any complications, electronic medical records (Alteer) were retrospectively reviewed.

Results:

The demographic characteristics of patients are listed in Table 1 and intra-operative data collected presented in Table 2. The overall major complication rate was 2.81% (19/709). Overall revision rate due to any cause was 1.83% (13/709). Wound related complications were 6.67% which included any type of drainage noted during post op clinic visits, wound dehiscence, stitch abscesses, or superficial infections requiring irrigation and debridement.

	Female	Male
Sample (709)	385	324
Mean age (years)	65.41 ± 11.41 (range, 29-91)	63 ± 11.8 (24-93)
Mean BMI (kg/m^2)	28.1 ± 5.6 (range 16-53)	29.9 ± 4.9 (19-47)
Mean follow-up time (months)	22 ± 7.5	19 ± 8.2

Table 1. Demographic data presented as mean values ± standard deviation.

Average surgical time (minutes)	59.4 ± 14.2 (range, 35-165)
Average estimated blood loss (mL)	293 ± 166.7 (range, 10-1200)
Femoral head diameter	
28 mm	17
32 or 36 mm	640
40 mm	54

Table 2. Surgical data with mean values ± standard deviation.

Number of cases	709	
Average length of hospital stay (days)	2.4 ± 1.3 (range, 1-8)	
Minor complications		
Iliopsoas tendonitis	13	1.83%
Rectus tendonitis	8	1.13%
Greater trochanter bursitis	62	8.75%
Iliotibial band pain	31	4.4%
Stitch abscess	11	1.55%
Wound complications	24	3.38%
Major complications		
Infection		
Superficial	5	0.71%
Deep	7*	0.98%
Failed THA	4*	0.70%
Peri-prosthetic fracture	1*	0.14%
Dislocation	2 (1*)	0.28%

Table 3. Post-operative data with incidences of major and minor complications. * indicates requiring revision surgery.

Discussion:

The anterior approach through a modified Smith-Petersen approach provides preservation of the major hip muscles to facilitate recovery. However, the lack of familiarity with the approach has prevented widespread adoption of the method. Our overall major complication rate was in the lower end of the range of published

complication rates (range, 1.36%-15.79%). Although the high incidence of wound complications is of concern, it can be explained by the location of the incision being in an area where large skin folds or moist skin make healing difficult. We have since implemented a preoperative protocol to sterilize the area near the inguinal area and included silver impregnated dressing to help decrease our wound related complications.

The Influence of Malrotation and Material of the Femoral Component on Patellofemoral Contact Mechanics and Wear During Gait

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Introduction

Malrotation of the femoral component is a cause of patellofemoral maltracking after TKA. Its precise effect on the patellofemoral (PF) mechanics has not been well quantified. The aim of this study was to investigate the effect of malrotation of the femoral component on PF initial contact area, initial contact pressure and wear after 4 million full gait cycles in TKA using a knee simulator. Moreover, the influence of the counterface material (CoCr or OxZr) on PF wear was also investigated.

Materials & Methods

Femoral components (FCs) were cemented onto specially designed fixtures, allowing positioning of the FC in different angles of axial rotation. Patellar buttons and FCs were then mounted in a Prosim knee simulator.

Patellofemoral contact mechanics

Seven axial rotation configurations were tested: neutral (FC parallel to the epicondylar axis), 2.5° endo- and exorotation, 5° endo- and exorotation and 7.5° endo- and exorotation.

Patellar contact location, contact area and contact pressure were measured dynamically during 20 gait cycles with a Tekscan sensor covering the patella collecting data at a rate of 100 frames per second.

Patellofemoral wear

For three alignments (neutral, 5° endo- and exorotation), a PF wear test of 4 million cycles in bovine serum (diluted to 40%) was done with three CoCr and three OxZr components on conventional ultra-high molecular weight polyethylene (UHMWPE, density: 0.93mg/mm^3). Every 0.5 million cycles the test lubricant was replaced, the patellar samples were cleaned and dried and polyethylene wear was measured gravimetrically. A linear regression model was used to calculate the wear rate of each patellar sample. Aggregate wear rates were determined for each test condition by pooling the measurements of all three patellar samples.

Results

For all six endorotation and exorotation configurations, the contact area was significantly lower and the contact pressure significantly higher than the neutral position ($p < 0.001$, Figs 1 and 2). In the patellofemoral wear test, the highest average wear rate was found in the group of endorotated CoCr femoral components (0.54 mm^3/Mcycle), but this is still only 11% of a typical tibiofemoral wear rate with the same CoCr component (5 mm^3/Mcycle). The following trends in the average wear rates could be observed: the average wear rate for CoCr (0.34 mm^3/Mcycle) was higher than for OxZr (0.19 mm^3/Mcycle) and the average wear rate for 5° endorotation (0.35 mm^3/Mcycle) was higher than for 5° exorotation (0.21 mm^3/Mcycle) and neutral alignment (0.23 mm^3/Mcycle) (Figs 3 and 4). None of these differences reached statistical significance ($p=0.05$), though.

Discussion

Our results indicate that both internally and externally malrotated femoral components significantly decrease contact areas and significantly increase contact pressures in the patellofemoral joint. These significant changes in contact pressure didn't translate in significant changes in wear, however. Overall, patellofemoral wear is very small compared to tibiofemoral wear, in all the configurations that we investigated.

Based on our results, we can conclude that clinical problems with patellar maltracking after femoral component malrotation seem not to be related to increased wear, but rather to pain and patellar instability.

Figures

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Figure 7

12A : Knee Mechanics: #807 September 23rd, 2011, 8:30-9:35

Influence of Joint Line Elevation on Kinematics and Collateral Ligament Strains in Revision Total Knee Arthroplasty

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Introduction

Optimal knee joint function obviously requires a delicate balance between the osseous anatomy and the surrounding soft tissues, which is distorted in the case of joint line elevation (JLE). Although several studies have found no correlation between JLE and outcome, others have linked JLE to inferior results. The purpose of this in vitro investigation was to evaluate the effect of JLE on tibiofemoral kinematics and collateral ligament strains.

Materials and Methods

Six cadaver knees were equipped with reflective markers on femur and tibia and CT scans were made. A total knee arthroplasty (TKA) was performed preserving the native joint level. The knees were then tested in passive flexion-extension and squatting in a knee kinematics simulator while marker positions were recorded with an optical system. During squatting quadriceps forces were measured as well as tibio-femoral contact pressures. Finally, a revision TKA was performed with JLE by 4 mm. The femoral component was downsized and a thicker insert was used. The knees were again tested as before.

Based on the bony landmarks identified in the CT scans and the measured trajectories of the markers, relative tibiofemoral kinematics could be calculated as well as distance changes between insertions of the collateral ligaments.

Statistical tests were carried out to detect significant differences in kinematic patterns, ligaments elongation, tibiofemoral contact pressures and quadriceps forces between the primary TKA and after JLE.

Results

Tibiofemoral kinematics are shown in Figure 1. For both passive flexion and squatting, tibial external rotation and adduction were similar before and after JLE.

In passive flexion, JLE decreased the posterior translation of the femoral medial and lateral condyle centres, especially beyond 40 degrees of flexion.

A slight 5% anterior shift of both centres was noted after JLE during squatting, but this was not significant.

Strains in the collateral ligaments are shown in Figure 2. The collateral ligament lengths remained constant during passive flexion and were unaffected by elevation of the joint line. During squatting, the sMCL stretched with

flexion after primary TKA and this behaviour stayed constant when the joint line was elevated. The LCL showed a similar loosening trend in both TKA configurations.

Also tibiofemoral joint kinetics were not affected by JLE: quadriceps force and contact pressures all remained essentially unchanged during squatting before and after JLE.

Discussion and conclusion

Although clinical observations have indicated that JLE is associated with inferior clinical results, the effects of JLE on knee biomechanics which might explain these outcomes remain relatively unknown. In this study, we specifically evaluated those effects on tibiofemoral kinematics and kinetics, as well as elongation of the collateral ligaments.

As our current study did not detect any effect of JLE in tibiofemoral kinematics, kinetics, and strains of collateral ligaments in revision TKA, it is possible that these effects may be limited to or triggered at the patello-femoral joint, and more significant with higher joint line elevations than the 4-mm level tested in the current study. This hypothesis needs to be further investigated in future in-vitro and in-vivo studies.

Figures

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Figure 3 HYPERLINK "http://app.istaonline.org/figures/1669.jpg" \t "_blank"
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Figure 4

7B : Shoulder: #543 September 22nd, 2011, 11:15-12:05

The Suboptimal Assembly of the Glenoidal Component in Reverse Shoulder Arthroplasty: The Mechanical Influence of Soft Tissue Interpositioning and Glenosphere Misalignment

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INTRODUCTION

Glenosphere disengagement can be a potential serious default in reverse shoulder arthroplasty [1]. To ensure a good clinical outcome, it is important for the surgeon to obtain an optimal assembly of the glenosphere - base plate system during surgery. However interpositioning of material particles (bone, soft tissue) between the contact surface of the glenosphere and the base plate and/or a misalignment of the glenosphere relative to the base plate can result in a suboptimal assembly of the glenosphere – base plate system [2]. This misalignment is typically caused by unwanted contact between the glenosphere and the scapula due to inadequate reaming. Both defects prevent the Morse taper from fully engaging, leading to a system configuration for which the assembly was not designed to be loaded in vivo. This study quantifies the influence these defects have on the relative movement between the glenosphere and metaglene.

MATERIALS AND METHODS

A biaxial test setup [Fig.1] was developed to mechanically load the glenoidal assembly (base plate + glenosphere) of 5 Depuy® Delta Xtend 38 prostheses. The setup allows applying a cyclic loading pattern to the glenoidal component with a constant actuator load of 750 N. Each of the 5 samples was tested for 5000 cycles on 3 defects: an interpositioning of 150 μm thick (0.48 mm^3) and two local underreaming defects, pushing one side of the glenosphere up 0.5 mm and 1 mm respectively, hence causing a misalignment. The relative movement was recorded using 4 Linear Variable Differential Transducers (LVDTs). The cycling frequency is 1 Hz.

RESULTS

A mean increase in relative movement of 26.84% (standard deviation: +- 18.2 %) and 38.04% (standard deviation

+- 28.73%) was measured for respectively the 0.5 and 1 mm misalignment defect. The interpositioning of material with a thickness of 150 μm thick caused the relative movement between glenosphere and metaglene to increase by 38.5 % (standard deviation +-26.56 %). For each sample and each defect the changes in relative movement between an optimal assembly and the suboptimal assemblies were significant at the 1% level.

DISCUSSION AND CONCLUSIONS

Relative cyclic movement between two components is an important wear and fatigue parameter. An increase in this parameter might lead to increased wear and fatigue problems. The results show how interpositioning and misalignment defects are linked to an important increase in relative cyclic movement between the glenosphere and metaglene and thus underline the importance of avoiding both defects leading to a suboptimal assembly during surgery.

[1] Molé, D. *et al.*, Montpellier: Sauramps Médical ; 289-301, 2006

[2] Middernacht, B. *et al.*, Clinical Orthopaedics and Related Research, Volume 466, Number 4, April 2008 : 892 – 898. Erratum in CORR 2008 Dec; 466(12) : 3163, 2008

Figures

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Figure 1 HYPERLINK "http://app.istaonline.org/figures/1678.jpg" \t "_blank" INCLUDEPICTURE \d "http://app.istaonline.org/figures/1678.jpg" * MERGEFORMATINET
Figure 2

6A : 3D planning and execution: #888 September 22nd, 2011, 8:30-9:35

Femoral Anterior Bow and Its Influence on TKA Femoral Placement and Size

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Traditional instrumentation relies on rigid IM rods to determine the distal femoral resection which influences size and orientation of the femoral component. Anterior femoral bowing may unexpectedly affect implant sizing. The purpose of this study was to determine the sensitivity of a flexible rod to the femoral anterior bow versus a traditional rod.

A database of 93 Asian bone models from CT images was utilized. The bones were subdivided into those having proximal third, distal third, or overall femoral bows. Only the latter group was selected for further analysis, which consisted of 54 with an average bow of 98cm (±20cm). The rigid and flexible rods were placed iteratively so that the proximal portion of the rod touched the anterior cortical-cancellous boundary and no portion of the rod protruded through that boundary. The flexible rod was allowed to flex, as a substantially thin central portion flexes exclusively in the sagittal plane. The relative angle difference between the position of the flexible and rigid rod were calculated.

Three femura were chosen from the subset with bows of 123cm, 100cm and 78cm. The femura showed differences between the rigid and flexible rod of 7.5^{o}, 4.5^{o} while no significant angle measured for the smallest bow. Implants were virtually assembled onto the bones and the greatest bowed femur's component reduced one size from the rigid to the flexible rod orientation.

The results of this study show that higher bowed femura yielded larger angular deviations between rigid and flexible rods. For higher bowed femura, the flexible rod allows smaller components to be implanted. The flexible rod serves the same purpose as a conventional rod by defining the distal valgus orientation but allows component orientation in the sagittal plane closer to the femoral bow.

3A : Navigation: #806 September 21st, 2011, 13:50-14:40

Comparison Between the Functional Flexion Axis of the Knee and the Transepicondylar Axis in Arthritic Knees

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Introduction

Several in vitro and in vivo studies have found correspondence between transepicondylar axis (TEA) and functional flexion axis (FFA) in healthy subjects. In addition some studies suggest that the use of FFA for rotational alignment of femoral implant may be more accurate than TEA. Ostheoarthritis (OA) may modify limb alignment and therefore flexion axis, introducing a bias at different flexion ranges during kinematic acquisition. In this study we want to understand whether OA affects somehow the FFA evaluation compared to TEA and whether the FFA could be considered a usable reference for implant positioning for osteoarthritic knees

Methods

We included a group of 111 patients undergoing TKA. With a navigation system, we recorded intraoperative kinematic data in three different ranges of motion (0°-120°; 35°-80°; 35°-120°). We compared the difference in orientation of FFA (computed with the mean helical axis method) in the three ranges as also the difference with the TEA on frontal and axial planes. The correlation of preoperative limb deformity with FFA and TEA was also performed.

Results

In OA patients an average difference of -2.8° ± 5.0° between TEA and FFA was found on frontal plane, while on axial plane results showed a difference of 0.6° ± 4.7°. No statistical difference was found among the three ranges in axial view whereas some difference was found in frontal view ($p<0.0001$). Angle between TEA and FFA was not correlated with limb alignment on axial plane, while it was, even if poor, in frontal plane.

Conclusions

In pathological knees there is the same correspondence between TEA and FFA both in frontal and axial plane and preoperative limb alignment does not correlate with orientation of FFA and TEA. Results are in agreement to studies on healthy subjects. FFA can be used as reference for femoral implant positioning in axial plane also in pathologic knees, while for the frontal plane further investigations are required.

Figures

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Figure 3 HYPERLINK "http://app.istaonline.org/figures/1715.jpg" \t "_blank"
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Figure 4

4B : Hip resurfacing: #882 September 21st, 2011, 14:50-15:40

Might Wear and Roughening of the Bearing Surface Be Linked With Early Femoral Neck Fracture in Metal-on-Metal Hip Resurfacing?

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Metal-on-metal hip resurfacing prostheses are a relatively recent intervention for relieving the symptoms of common musculoskeletal diseases such as osteoarthritis. While some short term clinical studies have offered positive results, in a minority of cases there is a recognised issue of femoral fracture, which commonly occurs in the first few months following the operation. This problem has been explained by a surgeon's learning curve and notching of the femur but, to date, studies of explanted early fracture components have been limited.

Tribological analysis was carried out on fourteen retrieved femoral components of which twelve were revised after femoral fracture and two for avascular necrosis (AVN). Eight samples were Durom (Zimmer, Indiana, USA) devices and six were Articular Surface Replacements (ASR, DePuy, Leeds, United Kingdom). One AVN retrieval was a Durom, the other an ASR. The mean time to fracture was 3.4 months. The AVNs were retrieved after 16 months (Durom) and 38 months (ASR).

Volumetric wear rates were determined using a Mitutoyo Legex 322 co-ordinate measuring machine (scanning accuracy within 1 micron) and a bespoke computer program. The method was validated against gravimetric calculations for volumetric wear using a sample femoral head that was artificially worn in vitro. At $5mm^3$, $10mm^3$, and $15mm^3$ of material removal, the method was accurate to within $0.5mm^3$. Surface roughness data was collected using a Zygo NewView500 interferometer (resolution 1nm).

Mean wear rates of $17.74mm^3$/year were measured from the fracture components. Wear rates for the AVN retrievals were $0.43mm^3$/year and $3.45mm^3$/year. Mean roughness values of the fracture retrievals (PV = 0.754, RMS = 0.027) were similar to the AVNs (PV = 0.621, RMS = 0.030), though the AVNs had been in vivo for significantly longer.

Theoretical lubrication calculations were carried out which found that in both AVN retrievals and in seven of the twelve cases of femoral fracture the roughening was sufficient to change the lubrication regime from fluid film to mixed. Three of these surfaces were bordering on the boundary lubrication regime. The results show that even before the femoral fracture, wear rates and roughness values were high and the implants were performing poorly.

13A : Robotics & navigation: #429 September 23rd, 2011, 11:15-12:05

Computer Assisted Total Knee Arthroplasty Following Prior Femural Fractures With Retention of Hardware

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Introduction:

Post traumatic arthritis of the knee can be a consequence of distal femur fracture and retained hardware can complicate any further surgical option including arthroplasty. Both staged surgical procedures to remove before the hardware or simultaneous procedure of arthroplasty and removal of hardware have been indicated with an increased risk of complications. Aim of this study is to present a consecutive series of TKA following distal femur fracture using a computer assisted technique without the removal of retained hardware assessing both the efficacy of navigation in managing these complex cases as "routinary" primary arthroplasties.

Material and Methods:

A consecutive series of 16 patients treated with a computer assisted TKR following femoral fracture and with retained hardware were included in the study (group A). The interval between the fracture and operation averaged 5.8 years (range 1-12 years), the retained hardware was an intramedullary nail in 6 cases, distal lateral plates in 7 cases and screws in 4 cases. All patients in group A were matched with a patient who had undergone to a computer assisted TKR using the same implant and software because of atraumatic knee arthritis in the same period (group B). Patients were matched in terms of age, gender, pre-operative range of motion, pre-operative arthritis severity according to Albaack classification, type and grade of deformity and implant features (cruciate retaining or sacrificing).There were 10 male and 6 female for each group, the mean pre-operative age was 64.3 years (range: 54 -72) for the group A and 65.4 years (range: 53-74) for the group B. The mean pre-operative flexion was 85.5 degrees (range: 65-115) and 88.1 degrees (range: 70-115) for the post traumatic group and the matched group respectively.

Results:

There were no statistical significant differences in surgical time, hospital staying, intra/post operative complications. Likewise at a mean follow-up of 47 months no statistically significant difference was seen for the Knee Society, Functional, GIUM and WOMAC scores between the 2 groups. Implant alignment was similar between the 2 groups with similar radiological parameters.

Conclusions:

The results of this study demonstrated that knee arthritis following distal femoral fracture can be safely managed using computer assisted TKA without any need of hardware removal and obvious costs savings. The Authors achieved both same results and same complication rate of similar uncomplicated primary TKR.

6B : Survival / Outcome: #664 September 22nd, 2011, 8:30-9:35

Predictors of Readmission After Total Hip and Total Knee Arthroplasty

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Introduction:

Readmission after Total Hip Arthroplasty (THA) or Total Knee Arthroplasty (TKA) places a great burden on the health care system. As reimbursement systems place increased emphasis on quality measures such as readmission rates, identifying and understanding the most common drivers for readmission becomes increasingly important.

Methods:

We queried an electronic database for all patients who underwent THA or TKA at our institution from 2006 through 2010. We identified those who were readmitted within 90 days of discharge from the initial admission and set this as our outcome variable. We then reviewed demographic and clinical data such as age, index procedure, length of stay (LOS), readmission diagnosis, co-morbidities and payer group and set these as our variables of interest. We used chi-square tests to characterize and summarize the patient data and logistic regression analyses to predict the relative likelihood of patient readmission based on our control variables. Statistical significance was defined as $p < 0.05$.

Results:

6436 patients underwent THA or TKA during the study period. Patients who were readmitted had a significantly higher mean LOS (4.7 days vs. 3.4 days, $p < 0.0001$). Patients with any co-morbid conditions (e.g., CHF, COPD, diabetes, PE, CAD) had higher readmission rates than those with none (18.7% vs. 7.8%, $p = 0.0002$). Adjusting for patient age, sex, race, payer type, and LOS, those with CHF or CAD were more likely to be readmitted compared to those without CHF or CAD (CHF: odds ratio [OR] =1.71, 95% confidence interval [CI]=1.03-2.84; CAD: [OR] =1.93, 95% CI=1.48-2.53).

Conclusions:

In our analysis of patients undergoing THA and TKA between 2006 and 2010, we found significant associations between readmission and higher LOS during initial admission and the presence of co-morbidities. Longer than average LOS and the presence of co-morbidities may be early predictors of readmission and warrant further study.

14B : Revision and difficult cases - Hip: #1118 September 23rd, 2011, 13:50-14:40

Less Invasive Rotational Acetabular Osteotomy for Hip Dysplasia: Indication and Surgical Technique

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BACKGROUND:

Our modified procedure for rotational acetabular osteotomy (RAO) aimed to reduce operative invasion of soft tissue and to minimize incision length.

SURGICAL TECHNIQUE:

A shortened skin incision (10-15 cm versus 20-30 cm in traditional RAO) is curved over greater trochanter and

exposed by transtrochanteric approach. Medial gluteus muscle is retracted to expose the ilium without detachment from iliac crest. Similarly the rectus femoris muscle tendon was retracted, not excised, from the anterior inferior iliac spine. The lateral part of the osteotomized ilium is cut in lunate and trapezoid shape to form the bone graft instead of the outer cortical bone of the ilium.

PATIENTS:

We performed RAO on 66 patients (75 hips) using this modified procedure between 2000 and 2009. Follow-up rate was 95% (71/75 hips). Of 71 hips, 28 had early-stage, and 43 had advanced-stage osteoarthritis. Mean patient age was 39.7 years at time of surgery. Mean length of follow-up was 5.3 years. Clinical assessment was performed using the Merle d'Aubigne & Postel scores. Radiographically, the lateral center-edge (CE) angle, the Sharp angle and acetabular head index (AHI) were evaluated pre- and post-operatively.

RESULTS:

Mean CE angle, Sharp angle and AHI improved pre- to post-operatively from -1.3 degrees to 36.5 degrees ($p<0.00001$), 50.3 degrees to 39.4 degrees ($p<0.00001$), 54.0 % to 95.7 % ($p<0.00001$), respectively. Clinical hip scores at latest follow-up were significantly improved. No progression of osteoarthritis was seen in hips with early-stage osteoarthritis. Ten hips with advanced-stage osteoarthritis preoperatively had radiographic evidence of progression of osteoarthritis, and six of those were converted to total hip arthroplasty. Complications included two transient lateral femoral cutaneous nerve palsies and ectopic bone formation in 15 hips, one of which required excision 1.5 years post-RAO. Kaplan-Meier survivorship analysis, with decreased clinical scores from pre-operatively and radiographic signs of progression of osteoarthritis as the end point, predicted a 10-year survival rate of 100% for early-stage osteoarthritis hips and 72.1 % for advanced-stage osteoarthritis.

CONCLUSIONS:

Less invasive surgical procedure for RAO preserved function of hip abductor muscle and did not adversely influence on clinical or radiographic outcome.

7B : Shoulder: #960 September 22nd, 2011, 11:15-12:05

Real-Time Mechanics of Native Shoulders and Total Shoulder Arthroplasties

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INTRODUCTION:

Total shoulder arthroplasty (TSA) implants are used to restore function to individuals whose shoulder motions are impaired by osteoarthritis. To improve TSA implant designs, it is crucial to understand the kinematics of healthy, osteoarthritic (OA), and post-TSA shoulders. Hence, this study will determine in vivo kinematic trends of the glenohumeral joints of healthy, OA, and post-TSA shoulders.

Methods:

In vivo shoulder kinematics were determined pre and post-operatively for five unilateral TSA subjects with one healthy and a contralateral OA glenohumeral joint. Fluoroscopic examinations were performed for all three shoulder categories (healthy, OA, and post-TSA) for each subject shoulder abduction and external rotation. Then, three-dimensional (3D) models of the left and right scapula and humerus were constructed using CT scans. For post-operative shoulders, 3D computer-aided design models of the implants were obtained. Next, the 3D glenohumeral joint kinematics were determined using a previously published 3D to 2D registration technique. After determining kinematics, relative Euler rotation angles between the humerus and scapula were calculated in MATLAB® to determine range of motion (ROM) and kinematic profiles for all three shoulder categories. The ROMs for each category were compared using paired t-tests for each exercise.

Also, the location of the contact point of the humerus on the glenoid was found. This allowed the vertical translation from the most superior to most inferior contact point (SI contact range) to be calculated as well as the

horizontal translation from the most anterior to most posterior contact point (AP contact range). The SI and AP contact ranges for all shoulder categories were compared using paired t-tests for each exercise.

Results:

Abduction - According to preliminary results, the averages range of abduction for healthy, OA, and post-TSA shoulders was 51.5 °, 19.4°, and 56.7°, respectively. The average SI contact range of abduction for healthy, OA, and post-TSA shoulders was 14.1 mm, 16.4 mm, and 14.1 mm, respectively while the AP contact range was 10.0, 14., and 14.3, respectively. The ranges of abduction between healthy and OA and between OA and post-TSA shoulders, and the AP contact range for healthy and OA shoulders displayed statistically significant differences at the α=0.05 level.

External Rotation- The averages range of External Rotation for healthy, OA, and post-TSA shoulders was 63.6°, 31.1°, and 44.5°, respectively. The averages SI contact range of External Rotation for healthy, OA, and post-TSA shoulders was 20.7, 12.7, and 15.9 mm, respectively while the averages AP contact range was 8.5,12.9 mm, and 13.8 mm, respectively. The ranges of abduction for healthy and OA as well as AP contact range for healthy and OA shoulders were statistically different at the α=0.05 level.

Conclusions:

This study's preliminary results indicate that healthy, OA, and post-TSA shoulders show statistically significant difference in kinematic trends including ROM and contact point translation. These differences may result from the varying geometries of each condition or from subjects altering kinematic trends to reduce pain in OA shoulders. In addition, this study may provide a reference for future studies analyzing the kinematics of post TSA shoulders.

12A : Knee Mechanics: #629 September 23rd, 2011, 8:30-9:35

The Development of a Predictive Physiological Rigid Body Model of the Knee

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Orthopaedic companies spend years and millions of dollars developing and verifying new total knee arthroplasty (TKA) designs. Recently, computational models have been used in the hopes of increasing the efficiency of the design process. The most popular predictive models simulate a cadaveric rig. Simulations of these rigs, although useful, do not predict in vivo behavior. Therefore, in this current study, the development of a physiological forward solution, or predictive, rigid body model of the knee is described.

The models simulate a non-weight bearing extension activity or a weight-bearing deep knee bend (DKB) activity. They solve for both joint forces and kinematics simultaneously and were developed from the ground up. The models are rigid body and use Kane's dynamical equations. The model began with a simple two dimensional non-weight bearing extension activity model of the tibiofemoral joint. Step by step the model was expanded. Quadriceps and hamstring muscles were added to drive the motion. Ligaments were added represented by multiple non-linear spring elements. The model was expanded to three-dimensions (3D) allowing out of plane motions and calculation of medial and lateral condylar forces. The patella was added as its own body allowing for simulation of the patellofemoral joint. The model was then converted to a weight bearing deep knee bend activity. A pelvis and trunk were added and muscles were given physiological origin and insertion points. A modified proportional-integral-derivative (PID) controller was implemented to control the rate of flexion and also to assist in joint stability by adjusting the force in individual quadriceps muscles. A method for representing articulating geometry was developed. Once the deep knee bend model was fully developed (Figure 1) it was converted back to a non-weight bearing extension model (Figure 2) resulting in simulations of a normal knee performing a weight bearing and non-weight bearing activity. The tibiofemoral kinematic results were compared to in vivo kinematics obtained from a fluoroscopy study of five normal subjects. Parameters from the CT models of one of these subjects (Subject 3) were used in the model.

The model kinematics behave as the normal knee does in vivo. The kinetic results were within reasonable ranges with a maximum total quadriceps force of 0.86 BW and 4.73 BW for extension and DKB simulations, respectively (Figure 3 and Figure 4). The maximum total tibiofemoral forces were 1.26 BW and 3.70 BW for extension and DKB, respectively. The relationship between the quadriceps force, patella ligament force and patellofemoral forces are consistent with how the extensor mechanism behaves (Figure 3 and Figure 4). The

patellofemoral forces are low between 0 and 20 degrees flexion and the patella ligament and quadriceps forces are close in magnitude from 0 to around 70 degrees flexion when the patellofemoral forces increase and the quadriceps forces increase relative to the patella ligament force. The model allows for virtual implantation of TKA geometry and after kinematic and kinetic validation from in vivo TKA data can be used to predict the behavior of TKA in vivo.

Figures

Keynote Lecture 8 : Future expectation of TKA by Yukihide Minoda: #1085 September 22nd, 2011, 13:40-13:55

Future Expectation of TKA

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September 23 13.40 - 14.00 Keynote 10

Future expectation of TKA

Yukihide Minoda [1], Yoshinori Kadoya [2], Akio Kobayashi [3], Hiroyoshi Iwaki [1], Kentarou Iwakiri [3], Takahiro Iida [1], Yoshio Matsui [5], Mitsuhiko Ikebuchi [1], Taku Yoshida [1], Shigeru Nakagawa [5], Hiroaki Nakamura [1]

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Abstract

Over the past decade, there has been an increase in the number of total knee arthropalsty (TKA). Demand of TKA for the young patients who often have high physical demands is also increasing. However, the revision rate in such young patients is much higher due to polyethylene (PE) wear and instability (Julin J, Acta Orthop 2010). Therefore, next generation total knee prostheses are expected to decrease PE wear and to provide stability.

Although *in vitro* study such as wear simulator test provides important information about PE wear, we have often encountered the discrepancy between the *in vitro* results and *in vivo* results. Thus we have performed *in vivo* PE wear particle analysis, and showed that *in vivo* PE wear was affected by the design of articulating surface and the materials of femoral component and PE insert (Minoda Y, JBJS Am 2009). Medial pivot design, ceramic femoral component, and highly cross-linked PE decreased *in vivo* PE wear particle generation.

Patients who underwent bilateral staged TKAs were more likely to prefer medial pivot prosthesis or ACL-PCL retaining prosthesis than the other types of prostheses, because they feels “more stable overall” (Pritchett JW, J Arthroplasty 2011). *In vivo* fluoroscopic 3D analysis showed that medical pivot and bi-cruciate substituting designs restored physiological knee motion and provided higher reproducibility (Mueller J. Komistek RD, Trans ORS 2009, Iwakiri K, Trans ORS 2007).

The excellent mid-term clinical results of those newly introduced total knee prosthesis, such as alumina medial pivot TKA (Iida T, ORS 2008), medial pivot TKA (Mannan K, JBJS Br 2009, Kakachalions T, Knee 2009), ACL-PCL retaining TKA (Clouter JM, JBJS Am 1999), and highly cross-linked PE (Hodrick JT, CORR 2008),

have been reported.

From the point of view of *in vivo* PE wear, *in vivo* stability, and the mid-term clinical results, we suspect that medial pivot prosthesis is one of the prostheses which meet the demand in future especially for young active patients.

5B : Spine: #782 September 21st, 2011, 16:20-17:10

Effects of Anterior Cervical Decompression and Fusion on Adjacent Level Kinematics

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Introduction:

Anterior cervical decompression and fusion (ACDF) is considered a standard surgical treatment to degenerative discogenic diseases. Lately, the question arises whether or not ACDF significantly influences the progression of adjacent disc degeneration (ADD). The etiology of ADD is obscure and it has not been fully understood whether ADD is a consequence of fusion or it represents the aging pathway of the degenerative cervical process, thus making it a controversial topic [1-3]. There have been several discussions about the possibility of ACDF altering biomechanical conditions at adjacent segments, therefore resulting in increased load and excessive motion [3,4]. The purpose of this study was to compare the cervical segmental motion pre- and post-ACDF using novel 3D analytical techniques.

Methods:

Nine patients (2F/7M, mean age: 54.1 years, range 36-76 y.o.) underwent ACDF due to symptomatic cervical degenerative discogenic disease. One-level ACDF was performed in 4 patients, whereas 2-level ACDF was done in five, using cylindrical titanium porous cage implants. Pre- and post (postoperative periods ranged from 11-months, 25 days to 12-months, 22 days, mean postoperative period: 12.09 months) surgery, dynamic-CT examinations were conducted in neutral, flexion and extension positions. Subject-based 3D CT models were created for segmental motion analysis (Fig. 1). Six-degrees-of-freedom 3D segmental movements were analyzed using a validated Volume-Merge methods (accuracy: 0.1 mm in translation, 0.2°in rotation) [5]. The segmental translation was evaluated by the segmental translations of gravity centers of endplates (Fig. 2). Disc-height distribution was measured using a custom-written Visual C++ routine implementing a lease-distance calculation algorithm. The mean translation distance was calculated for the each adjacent level (Fig. 2). Differences of segmental motions and mean disc height between pre- and post-surgery at each level were compared by the Wilcoxon signed rank test. Results were presented mean±SEM.

Results:

Regarding the fusion level, the data shows decreases in both the flexion/extension (F/E) angular range of motion (ROM) (7.46±1.17°preoperatively vs. 3.14±0.56°post-operatively, $p<0.003$) and the segmental translation in the anterior/posterior direction (AP translation) after surgery (1.22±0.20 mm pre-operatively and 0.32±0.11 mm post-operatively, $p<0.01$). For the adjacent levels category (inferior and superior combined), the E/F angular ROM was larger after surgery (6.74±1.22°pre-operatively vs. 8.48±0.56°post-operatively, $p<0.03$). The lateral and axial rotational angular ranges of motion pre- and post-surgery did not show any statistically differences at the adjacent levels. The AP translation at the adjacent levels did not change after surgery (1.22±0.26 mm pre-operatively and 1.45±0.29 mm post-operatively). Translations in lateral and cranio-caudal directions also did not show change following surgery. The mean disc height in the adjacent level (2.39±0.14 mm) showed no differences with respect to the post-surgical measurements (2.40±0.19 mm).

Conclusions:

The use of a high-accuracy *in vivo* 3D kinematic analysis method enabled the detection of subtle changes in segmental movement between pre- and post-ACDF conditions. The result of the current study showed increased segmental movements in F/E angles at the adjacent level. These results are consistent with the some previous studies in the literature [4,6-11]. The magnitude of the increased movement, however, was only 1.74°from full-full-flexion to full-extension and no increase was found in AP translation. No disc height loss associated with disc degeneration was observed during a 1-year period after ACDF. Longer follow-up studies with larger patient cohorts will be required to investigate whether the increased F/E angle at the adjacent level effectively causes symptomatic ADD

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Figure legends:

Fig. 1. Representative patient-based 3D CT computer models in flexion, neutral and extension position. Fusion level: C4/5.

Fig. 2. Local coordinate system and gravity center of the endplates of a motion segment used in segmental translation analysis and quantification of its corresponding disc height distribution. Color scale bar is in mm, ranges; 1 to 4 mm.

Fig. 3. Comparison of the pre- and postoperative conditions for motion parameters at the fusion level and the adjacent levels. Left: Angular range of motion (ROM) for the Flexion/Extension motion in degrees. Right: Anterior-posterior segmental translation in mm. Error represents the standard error of the mean.

2B : Patient management: #810 September 21st, 2011, 11:15-12:05

IN VITRO ANTIBIOTIC SUSCEPTIBILITY of Staphylococcus Aureus and Staphylococcus Epidermidis ISOLATED FROM RETRIEVED PROSTHETIC IMPLANTS

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INTRODUCTION:

Prosthetic joint related-infections (PJRI) are severe complications in orthopaedic surgery. *Staphylococcus aureus*

and *Staphylococcus epidermidis* are the most commonly isolated pathogens from implants (1). The variable antimicrobial susceptibility found in these microorganisms, makes it necessary to perform individual susceptibility studies in order to select the best antibiotic combination for clinical management (2).

MATERIAL AND METHODS:

35 staphylococcal strains *(*17 *S. aureus,* 18 *S. epidermidis)* were isolated from PJRI using a previously described sonication protocol (3). Biofilm-producing collection strains *S. aureus* 15981 (4) and *S. epidermidis* ATCC 35984 were also included in the study. *In vitro* susceptibility was evaluated against 7 antimicrobial agents: rifampin, vancomycin, ciprofloxacin, cotrimoxazole, cloxacillin, clindamycin, and daptomycin. Minimal Inhibitory Concentration (MIC) assays were determined according to EUCAST recommendations and breakpoints (5). Minimal Bactericidal Concentration (MBC) was also calculated by colony counting after plating the well contents.

RESULTS:

Antibiotic susceptibility assay results are shown in tables 1 and 2. It is especially remarkable the high number of meticillin-resistant S. aureus (MRSA) strains. Cotrimoxazole and clindamycin showed better results for S. aureus. Rifampin, vancomycin, and daptomycin showed a very good activity, although some resistant strains were detected for the first two. MBC values showed a strain-dependant activity of rifampin and vancomycin. Only daptomycin showed bactericidal activity against all the tested strains.

DISCUSSION & CONCLUSIONS:

The treatment of PJRI is still a challenge due to the variable antibiotic susceptibility and the growing number of multidrug-resistant strains. The high number of MRSA detected in our study, makes it necessary to search other antibiotics as an alternative to vancomycin, the traditional elective treatment. The high *in vitro* activity of daptomycin against the tested strains suggests that it could be an important alternative according to other promising results (6). Rifampin associated with other antimicrobials and cotrimoxazole, with a good *in vitro* activity against most MRSA strains, could be other potential strategies (7, 8).

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ACKNOWLEDGEMENTS:

This study was funded by grants from Spanish Ministry of Science (FUNCOAT-CSD2008-00023) and Comunidad de Madrid (S2009/MAT-1472-1). DMM was granted by Fundación Conchita Rábago de Jiménez Díaz. AOP and GDP were funded by the Comunidad de Madrid.

Figures

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Figure 3 HYPERLINK "http://app.istaonline.org/figures/1608.jpg" \t "_blank"
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Figure 4

The Effect of Traditional vs Single Use Instrumentation on or Efficiency in Navigated Primary TKA

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Summary:

Single use instrumentation had a significant reduction on OR Turnover time and instrument setup/clean up time compared to traditional instrumentation.

Introduction:

Recently, focus has shifted to improving OR efficiency by surgeons and hospital admin. The purpose of this study was to determine the effect of traditional instrumentation vs. single use instrumentation (SUI) on OR efficiency in navigated primary TKA.

Methods:

This prospective randomized study was conducted at a single center, community hospital by a single surgeon. Patients were split into two groups: Group 1 (Navigated Traditional (n=23)) and Group 2 (Navigated SUI (n=26)). Efficiency was examined by measuring specific time intervals based on milestones in the OR preparation, surgical procedure, and OR cleanup.

Results:

Instrument set up time was reduced by an average of 8.5 minutes (min) in Group2 vs. Group1 (p=0.00). Patient set up took slightly longer in Group2 (1.47 min) but not statistically significant (p=0.50). Both groups had similar procedure time (p= 0.21) and patient OR Time (120 min for both groups p=0.93). Instrument clean up time was significantly shorter in Group 2 (difference 3.44 min (p=0.01). Overall surgical episode was significantly faster in the Group 2 by 9.57 min (p=0.02). Tourniquet time significantly reduced in the Group 2 by 4.92 min (p=0.02). Overall Instrument set up and clean up was faster by 11.94 min in Group 2 vs. Group 1. Notably, the OR turnover time was reduced by 23.52 min in the Group 2 vs. Group 1.

Conclusion:

Single-use instruments had a significant reduction on OR Turnover time and instrument setup/cleanup time compared to traditional instrumentation. A larger prospective trial is warranted.

Comparison of Robot-Assisted and Conventional Total Knee Arthroplasty: a Controlled Cadaver Study Using Multiparameter Quantitative Three-Dimensional CT Assessment of Alignment

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A functional total knee replacement has to be well aligned, which implies that it should lie along the mechanical axis and in the correct axial and rotational planes. Incorrect alignment will lead to abnormal wear, early mechanical loosening, and patellofemoral problems. There has been increased interest of late in total knee arthroplasty with robot assistance. This study was conducted to determine if robot-assisted total knee arthroplasty is superior to the conventional surgical method with regard to the precision of implant positioning.

Twenty knee replacements of ten robot-assisted and another ten conventional operations were performed on ten cadavers. Two experienced surgeons performed the surgery. Both procedures were undertaken by one surgeon on

each cadaver. The choice of which was to be done first was randomized. After the implantation of the prosthesis, the mechanical-axis deviation, femoral coronal angle, tibial coronal angle, femoral sagittal angle, tibial sagittal angle, and femoral rotational alignment were measured via three-dimensional CT scanning. These variants were then compared with the preoperative planned values.

In the robot-assisted surgery, the mechanical-axis deviation ranged from -1.94 to 2.13° (mean: -0.21°), the femoral coronal angle ranged from 88.08 to 90.99° (mean: 89.81°), the tibial coronal angle ranged from 89.01 to 92.36° (mean: 90.42°), the tibial sagittal angle ranged from 81.72 to 86.24° (mean: 83.20°), and the femoral rotational alignment ranged from 0.02 to 1.15° (mean: 0.52°) in relation to the transepicondylar axis. In the conventional surgery, the mechanical-axis deviation ranged from -3.19 to 3.84°(mean: -0.48°), the femoral coronal angle ranged from 88.36 to 92.29° (mean: 90.50°), the tibial coronal angle ranged from 88.15 to 91.51° (mean: 89.83°), the tibial sagittal angle ranged from 80.06 to 87.34° (mean: 84.50°), and the femoral rotational alignment ranged from 0.32 to 4.13° (mean: 2.76°) in relation to the transepicondylar axis. In the conventional surgery, there were two cases of outlier outside the range of 3° varus or valgus of the mechanical-axis deviation. The robot-assisted surgery showed significantly superior femoral-rotational-alignment results compared with the conventional surgery (p=0.006). There was no statistically significant difference between robot-assisted and conventional total knee arthroplasty in the other variants. All the variants were measured with high intraobserver and interobserver reliability.

In conclusion, Robot-assisted total knee arthroplasty showed excellent precision in the sagittal and coronal planes of the three-dimensional CT. Especially, better accuracy in femoral rotational alignment was shown in the robot-assisted surgery than in the conventional surgery despite the fact that the surgeons who performed the operation were more experienced and familiar with the conventional surgery than with robot-assisted surgery. It can thus be concluded that robot-assisted total knee arthroplasty is superior to the conventional total knee arthroplasty.

Keynote Lecture 14 : Is Bigger Really Better? by Michael Morlock: #428 September 23rd, 2011, 13:35-13:50

Is Bigger Really Better?

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Head sizes used in total hip arthroplasty (THA) has increased drastically from the original 22mm used by Charnley. This is due to two factors: the use of hard-on-hard materials for the bearing articulation and the increasing problem of dislocation.

The tribological aspect: Hard-on-hard materials enable mixed or fluid film lubrication due to their good wettability. The development of a fluid film layer is encouraged by smaller surface pressures (larger area) and higher velocity at the articulating interface (larger radius), suggesting that larger diameters exhibit better lubrication and such less wear. This was effectively proven in pre-clinical simulator studies and used as argument to increase the diameters of metal-on-metall and ceramic-on-ceramic bearings. Clinically the tribological advantage of larger diameters has not yet been shown. For hard-on-soft bearings the situation is different. Due to the bad wettability of Polyethylene (PE), the abrasive wear regime is dominant. This means that the longer wear path of a larger diameter will inevitably carry a larger amount of wear debris. Despite this relation, the heads used in combination with PE were also increased up to 40mm diameter, justified by the overall greatly reduced wear amount of the new generation(s) of cross-linked PE and favourable simulator results. First in-vivo studies have shown that larger heads carry larger amounts of wear particles. Whether this increase is relevant with respect to osteolysis is still unclear and will have to be shown in longer term studies.

The biomechanical aspect: Larger heads require a larger "jumping" distance until they dislocate. Consequently the use of larger heads reduces dislocation rates, which was shown in multiple clinical studies. However, the reduction in dislocation rate achieved by increasing diameters varies greatly. Some centres achieve dislocation rates below 1% with 28mm heads, other centres require 36mm heads to achieve the same result. No study shows any further advantage with head diameters larger than 36mm. Despite their obvious biomechanical advantage with regard to stability, larger heads also have large disadvantages. Larger heads carry inevitably larger friction moments, requiring better anchoring of the components. In unfavourable conditions (start-up, break-down of lubrication film), friction moments of hard-on-hard bearings can get very high and reach or even exceed the loosening torque of the head on the taper. Depending on the head impaction force during assembly, the loosening torques amount to 8 to 17Nm. Movement at the head-taper connection possibly causes wear and increased

corrosion at this interface. Larger head diameters also require thinner shells and/or liners, leading to problems with liner chipping or incomplete seating. Large head diameters have also lead to the use of sub-hemispherical cups with reduced covering surface, increasing the risk of fluid film break down due to edge loading if not well positioned. Finally, larger heads might give the surgeon a wrong feeling of security regarding a sub-optimal positioned cup.

The question regarding "the optimal" head diameter is open for discussion and needs to consider the bearing material used. Head size should be limited to a reasonable compromise, which based on the information currently available, could be 36mm. Join the "36 and under" club.

2A : CAOS session: #558 September 21st, 2011, 11:15-12:05

VALIDATION of Ipod BASED NAVIGATION SYSTEM for TOTAL KNEE ARTHROPLASTY

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Navigation has shown to improve limb and component alignment during total knee arthroplasty (TKA). However, most navigation systems involve bulky and expensive hardware, increased operative time and cost. A novel hand-held image-free navigation device has been recently approved with the aim to reduce inventory, cost and surgical time with its small size and quick registration features. We aimed to determine limb and component alignment and validate the accuracy of the iPod based navigation system.

Intraoperative navigation data for proximal tibia and distal femur cuts, femoral component rotation, limb alignment and component alignment in routine imageless navigation system (Ci Navigation, Brainlab) was compared with the novel iPod-based hand-held navigation system (DASH, Smith & Nephew) in 20 TKAs. Postoperative full-length hip-to-ankle and lateral radiographs were evaluated to measure the hip-knee-ankle (HKA) angle and coronal and sagittal alignment of the femoral and tibial component.

The iPod-based navigation system showed good agreement with the Ci Navigation system for limb alignment, tibial and distal femoral cuts in the majority of the limbs despite its quick registration feature. The iPod-based system is hence a positive step towards making navigation systems for TKA more compact, user-friendly, time and cost-effective.

Keynote Lecture 3 : Benifits of navigation in TKA by Arun Mullaji: #1129 September 21st, 2011, 13:35-13:50

Benefits of Navigation in TKA

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There is ample data to confirm that Computer-assisted total knee replacement improves alignment of the limb when compared with the conventional technique. There is also published evidence that optimum alignment correlates with longevity of implants. CAS enables accurate component alignment of both femoral and tibial components. It enables accurate restoration of the posterior tibial slope which has important consequences for flexion range and stability of the component in flexion especially if mobile bearing implants are considered. CAS also aids in correctly orienting rotation of the femoral component; this has value in minimizing patellar maltracking. We will present our data showing accurate restoration of joint line and posterior femoral offset. As CAS ensures alignment, rotation, sizing and positioning of components, the surgeon is free to devote his efforts to ensuring soft-tissue balance and stability, since TKA is really a ‘soft-tissue’ operation.

How CAS is of immense value in deformity correction and soft-tissue balancing will be illustrated with examples. It helps in better understanding and quantification of the effects of soft-tissue release on flexion-extension gaps and this is of great value not only for minimal deformities (to minimize releases) but also for severe deformities (to ensure complete correction by adequate release). CAS is invaluable in helping equalize flexion-extension gaps; how it can help balance the flexion gap to the extension gap by ‘virtual surgery’ will be depicted with examples. It is particularly useful in presence of hardware in the femur or tibia and for concomitant extra-articular deformity.

We have also found a consistent improvement in recovery of functional milestones with CAS with similar results for both unilateral and bilateral TKAs. Furthermore, there is evidence to support that ensuring alignment has important benefits in improving functional and quality of life scores. In addition, those with alignment of mechanical axis within 3 degrees of normal have been shown to have a shorter stay in hospital by 2 days. Studies

have shown reduced blood loss and incidence of emboli after CAS TKA.

Using CAS routinely for all cases, the author is 'time neutral'. While there is always room for improvement with evolving technologies and CAS is no exception, it already has enormous benefits in the performance and outcome of TKA, and is an important part of the surgical armamentarium for a successful knee arthroplasty.

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11A : Knee kinematics: #503 September 22nd, 2011, 17:40-18:30

In Vivo Kinematics of Bi-Surface Total Knee System

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Introduction:

Achieving high flexion after total knee arthroplasty is very important for patients in Asian countries where deep flexion activities are an important part of daily life. The Bi-Surface Total Knee System (Japan Medical Material, Kyoto, Japan), which has a unique ball-and-socket mechanism in the mid-posterior portion of the femoral and tibial components, was designed to improve deep knee flexion and long-term durability after total knee arthroplasty (Figure 1). The purpose of this study was to determine the in vivo three-dimensional kinematics of Bi-Surface Total Knee System in order to evaluate and analyze the performance of this system with other conventional TKA designs currently available in the market today.

Materials and Methods:

Three-dimensional kinematics were evaluated during a weight-bearing deep knee bend activity using fluoroscopy and a 2D-to-3D registration technique for 66 TKA. Each knee was analyzed to determine femorotibial kinematics, including weight-bearing range of motion, anterior/posterior contact position, and tibio-femoral rotation.

Results:

The average weight-bearing range of motion for the entire group was 125.5Ë�. Forty three of sixty six knees had greater range of motion than 120Ë�. At full extension, the average contact positions were -0.5mm (range, from -12.2mm to 6.8mm; standard deviation 3.5mm), and -3.8mm (range, from -14.1mm to 6.0mm; standard deviation 4.9mm) for the medial compartment and the lateral compartment, respectively. At maximum flexion, the average contact position was -9.2mm (range, from -17.8mm to 2.4mm; standard deviation 3.7mm), and -14.8mm (range, from -20.1mm to 5.7mm; standard deviation 2.7mm) for the medial compartment and the lateral compartment, respectively (Figure 2). From full extension to maximum flexion, the average posterior femoral rollback observed was -8.7mm (range, from -22.1mm to 1.0mm; standard deviation 4.3mm) for the medial compartment, and

-11.0mm (range, from -21.9mm to 6.6mm; standard deviation 5.4mm) for the lateral compartment. At full extension, the average axial orientation was 3.8Ë (range, from -5.3Ë to 26.4Ë; standard deviation 5.2Ë) of external femoral rotation. At maximum flexion, the average axial orientation was 9.5Ë (range, from -5.9Ë to 27.7Ë; standard deviation 6.7Ë). Therefore, from full extension to maximum flexion, the average amount of axial rotation was 5.7Ë (range, from -15.1Ë to 22.2Ë; standard deviation 6.4Ë).

Discussion:

The Bi-Surface Knee System was designed to accommodate the life style led by Asian populations, by aiming to improve both, knee flexion and long-term durability. Though durability of the device is beyond the scope of this study, subjects in this study did achieve high weight-bearing flexion, excellent posterior femoral rollback of both condyles and a normal axial rotation patterns, albeit, less than the normal knee. Also, this is the first in vivo study conducted to understand the kinematic patterns generated for subject implanted with this device. The amount of posterior rollback and axial rotation were found to be similar in nature to the normal knee as well as other established TKA devices available for implantation today, but again less than the normal knee.

Figures

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Figure 2

Keynote Lecture 12 : Bioactive Titanium applied for implant and bone substitute by Takashi Nakamura: #1074 September 23rd, 2011, 11:00-11:15

Bioactive Titanium Applied for Implant and Bone Substitute

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Bioactive Titanium Applied for Implant and Bone Substitute

Takashi Nakamura, M.D., Ph. D.

Director of Kyoto Medical Center

Professor Emeritus, Kyoto University

It is very important to fix implant to bone. Bioactive materials as hydroxyapatite or glass-ceramics have bone-bonding ability. Hydroxyapatite-coating is applied to cementless THA or TKA. I and coworkers investigated bone-bonding mechanism of bioactive material and found that bone-like apatite formation play key role for bonding. If the surface of metal is changed to form apatite on it in body, the inert metal changes into bone-bonding material. We developed alkaline and heat treatment of titanium to change titanium to bone –bonding material as follows. At first, titanium is dipped in 5N NaOH solution for 24 hours, at second the metal is washed in pure water and finally it is sintered in 500 degree C for 2 hours. The treated surface has bioactivity, bone bonding ability like hydroxyapatite. The advantage of this treatment over hydroxyapatite-coating procedure is to treat the porous surface without any change of pore figures. As to hydroxyapatite-coating procedure, pore of the small diameter is filled with hydroxyapatite and pore figures are change. We applied this alkaline and heat treatment to cementless THA and its good results of more than ten years was reported.

Porous titanium can be changed to bioactive material by alkaline and heat treatment. This bioactive porous titanium was found to have a property of material-induced osteoinduction, that is, the bone formation in pore of porous titanium implanted in canine back muscle. They can be used for bone substitute for big bone defect. We used two procedures to make porous titanium, sintering of titanium powder with spacer particle of ammonium sulfate and selective lazar melting. The latter procedure can produce any type of pore structure of titanium. Selective laser melting was employed to fabricate porous Ti implants (diameter 3.3 mm, length 15 mm) with a channel structure comprising four longitudinal square channels, representing pores, of different diagonal widths, 500, 600, 900, and 1200 micrometer. These were then subjected to chemical and heat treatments to induce bioactivity. Significant

osteoinduction was observed in widths 500 and 600 micrometer, with the highest observed osteoinduction occurring at 5 mm from the end of the implants. A distance of 5 mm probably provides a favorable balance between blood circulation and fluid movement.

New bioactive bone cement is another topic of the application of bioactive titanium in this lecture. The bone cement contains barium sulphate for radiocontrast. We developed a procedure to replace barium sulphate with bioactive titanium powder. This new bone cement has not only better biocompatibility than conventional cement but also bone bonding ability. It is potent material for the fixation of implant to bone. I will speak the evaluation of this cement using canine model of THA.

9A : Future technologies: #808 September 22nd, 2011, 14:55-15:45

Effect of Fiber Morphology on Short-Fiber Reinforcement of Calcium Phosphate Cement

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Background:

Calcium phosphate cement (CPC) is a promising biomaterial which can be used in numerous medical procedures for bone tissue repairing because of its excellent osteoconductivity. An injectable preparation and relatively short consolidation time are particularly useful characteristics of CPC. However, the low strength of CPC and its brittleness restrict its use. One method for toughening brittle CPC is to incorporate fibrous materials into its matrix to create a composite structure. Fibers are widely used to reinforce matrix materials in a variety of areas.

Objective:

We hypothesized that there must be an optimal fiber length and structure which can balance these conflicting aspects of fiber reinforcement. The purpose of this study is to prove our conjectures that adding a small amount of short fibers significantly improves the hardness and the toughness of CPC while maintaining its injectability with a syringe and that fiber morphologies that have crimps and surface roughness are favorable for reinforcing.

Material and Methods:

We used 3 types of short fibers of approximately 20-50 micrometer in diameter and 2 mm in length in this study: crimpy wool, crimpy polyethylene and straight polyethylene fibers. All of the materials were prepared by mixing a solvent with CPC powder with or without fiber. We grouped as follow, the control group, the wool group, the crimpy polyethylene group, the straight polyethylene group. After soaking in 37 degrees Celsius Simulated Body Fluidãï¿½ï¿½ for 1, 3, or 7 days, they were tested for each period. Impact strength test by the falling weight and compression test were performed.

Result:

In the impact strength test, after soaking for 1 day, impact resistance in the wool group was approximately 180 times greater than in the control group. When soaking for 3 days or more, impact resistance of wool group improve better than control group. The impact resistance of the wool group was the greatest among the four groups in soaking for 3 days. In the compression test, the yield strength and ultimate strength of the wool group were significantly higher than ultimate strength of the control group. The wool group has stress–strain curves that are typical of those of ductile materials, whereas the stress–strain curves of the control group resemble those of brittle materials. This indicates that fiber reinforcement drastically alters the physical properties of CPC converting it from brittle to ductile.

Conclusion:

In the present study, we sought to develop a method for producing injectable fiber-reinforced CPC. We focused on morphology and surface roughness of fiber in the reinforcement of CPC. This study clearly showed that CPC was substantially strengthened and toughened by crimpy short fiber reinforcement. CPC reinforced with short fibers which have morphology similar to wool should be a promising tool for orthopedic surgeons.

15B : Bearing materials: #553 September 23rd, 2011, 14:50-15:40

Ultrasound Screening of Periarticular Soft-Tissue Abnormalities Around Metal, Ceramic, and Polyethylene Bearings

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Purpose:

There are concerns of soft-tissue reactions such as metal hypersensitivity or pseudotumors for metal-on-metal (MoM) bearings in hip arthroplasty, however, such reactions around ceramic or polyethylene bearings are incompletely understood. The present study was conducted to examine the capabilities of ultrasound screening and to compare the prevalence of periarticular soft-tissue lesions among various types of bearings.

Methods:

Ultrasound examinations were conducted in 163 hips (153 patients) with arthroplasty after mean a follow-up of 8.1 years (range, 1–22 years). This included 39 MoM hip resurfacings (M-HR) including 30 Birmingham hip resurfacings (BHR) and 9 ADEPT resurfacings; 36 MoM total hip arthroplasties (M-THA) with a large femoral head including 26 BHR and 10 ADEPT bearings; 21 ceramic-on-ceramic THAs (C-THA) of Biolox forte alumina bearings; 24 THAs with a conventional polyethylene liner (cPE-THA) including 19 Lubeck and 5 Omnifit systems; and 43 THAs with a highly cross-linked polyethylene liner (hxPE-THA) including 28 Crossfire and 15 Longevity liners. All procedures were performed in the lateral position through the posterior approach without trochanteric osteotomy. The M-HR group had a significantly higher frequency of male patients than the C-THA, cPE-THA, and hxPE-THA groups, and the patients in the M-HR group were younger than those in the other four groups. Ultrasound images were acquired as a still picture and in video format as the hip moved in flexion and rotation, and 4 qualitative classifications for periarticular soft-tissue reactions were determined as normal pattern, joint-expansion pattern (marked hypoechoic space between the anterior capsule and the anterior surface of the femoral component), cystic pattern (irregularly shaped hypoechoic lesions), and mass pattern (a large mass extending anterior to the femoral component). Magnetic resonance imaging (MRI) was subsequently performed in 45 hips with high-frequency encoding bandwidths. For the reliability of ultrasound screening, positive predictive value, negative predictive value, and the accuracy of the presence of abnormal patterns on ultrasound were calculated using the abnormal lesions on MRI as a reference.

Results:

Among the 45 hips that underwent MRI, periarticular abnormal lesions were detected in 26 hips (58%). Using MRI findings as reference, positive predictive value, negative predictive value, and the accuracy of ultrasound examination for the detection of soft-tissue lesions were 83%, 71%, and 78%, respectively. Abnormal ultrasound lesions with joint expansion, cystic, or mass patterns were most frequently observed in the cPE-THA group (50%), followed by the M-THA (25%), hxPE-THA (23%), M-HR (18%), and C-THA groups (14%). Compared to the hxPE-THA group, the frequency of abnormal patterns did not differ significantly in the two MoM groups. A mass pattern was detected in 3 hips of the M-THA group and 1 hip of the C-THA group (Figure 1). Abnormal ultrasound lesions were significantly associated with the presence of symptoms.

Conclusion:

Various soft-tissue reactions could be observed other than those for MoM bearings, and pseudotumors may not be a specific feature of MoM bearings. Ultrasound examination may be a suitable screening tool for further large prospective investigations of soft-tissue reactions around various types of bearings.

Figures

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Figure 1

8B : Bearings - hip: #596 September 22nd, 2011, 13:55-14:45

Ten-Year-Follow-up Study of Ceramic-on-Ceramic Total Hip Arthroplasty With Modular Necks

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Purpose:

Ceramic-on-ceramic bearings in total hip arthroplasty (CoC THA) have theoretical advantages of wear resistance and favorable biocompatibility of ceramic particles to the surrounding bony and soft tissue. Long-time durability of CoC THA has been expected, however, clinical results over 10 years after operation were scarcely reported. In the present study, clinical results at follow of 10 years were examined for CoC THAs with a changeable femoral neck which allowed correction of anteversion of the femoral component in cases with abnormal femoral anteversion in dysplastic hips.

Methods:

During 1997 and 2000, 203 cementless CoC THAs in 158 patients were conducted in our hospital. Six patients died because of unrelated causes and 5 patients were lost to followup, and the remaining 188 hips in 147 patients were analyzed at the mean followup period of 10.8 years (3.7 to 13.5). There were 24 men and 123 women, and the average age at operation was 54 years (26 to 73). The hip diseases for operation were osteoarthritis in 165 hips, osteonecrosis of the femoral head in 21 hips and failure of hemiarthroplasty in 2 hips. The operation was performed in the lateral position through the posterior approach without trochanteric osteotomy. The articulation was composed of Biolox forte alumina liner fitted into beads-coated hiemispherical titanium shell, and a 28-mm Biolox forte alumina femoral head (Cremascoli). The femoral component was either AnCA stem or custom-designed stem, coupled with a modular neck allowing selection of 5 variable offsets and anteversions (Cremascoli). Clinical and radiological findings, and complications during the followup period were analyzed.

Results:

During the follow-up, 8 hips were revised, due to repeated dislocation (2 hips), periprosthetic fracture (1 hips), cup loosening (1 hip), fracture of ceramic liner rim (2 hips), and cup loosening along with ceramic liner rim fracture (2 hips). Cup abduction angle of the 4 cases with ceramic liner rim fracture were high at 49 degrees or more, as compared with the mean cup abduction angle of 41 degrees in the other hips without ceramic fracture. The survival rate at 10 years was 96.0 % when failure was revision. In the hips other than the revised cases, 6 hips showed cup loosening and no hip showed stem loosening on radiographs. Osteolysis was seen in 3 hips around the cup and 4 hips around the stem. Nineteen patients (10%) complained of abnormal noises around the hip, but most of the noises were click sound.

Discussion:

The 10-year results of cementless CoC THAs with a modular neck were favorable with few cases of osteolysis. However, relatively high frequency of cup loosening may be a concern, since increased cup abduction angle associated with cup loosening may cause ceramic liner fracture.

6B : Survival / Outcome: #830 September 22nd, 2011, 8:30-9:35

The Key to Satisfaction Following TKA: Results From the New Knee Society Scoring System

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Introduction:

The new Knee Society Score has been developed and validated, in part, to characterize better the expectations, components of satisfaction, and the physical activities of the younger, more diverse modern population of TKA patients. This study aims to reveal patients' activity levels' post-TKA and to determine how it contributes to their

subjective evaluation of the surgery.

Methods:

As part of a multi-centered and regionally diverse study sponsored by the Knee Society, the new Knee Society Score (KSS) was administered 243 patients (44% male; avg 66.4years; 56% female, avg 67.7years) following primary TKA (follow up > 1year, avg. 25mos). The new, validated KSS questionnaire consists of a traditional objective component, as well as subjective components inquiring into patient symptoms, satisfaction, expectations and activity levels as well as a survey of three physical activities that are viewed as important to the patients. Responses were analyzed as a whole group and as subgroups of male and female and as younger (<65) and older (>65).

Results:

Post-TKA, knee function met or exceeded 84% of patients' expectations, with 49% of patients reporting that their knee always feels normal. While performing standard activities (eg turning, climbing stairs), the majority of patients (78%) experienced few symptoms referable to the knee. Fewer (47%) report that they remain asymptomatic while performing more demanding ('advanced') activities (eg squatting, running). Distance walking (52%), swimming (28%) and stationary biking (25%) were among activities that were most commonly selected as personally important. Activities such as golf (Male 39%; Female 6%; $p<0.001$) and road cycling (Male 19%; Female 4%; $p<0.001$) were important to more men than women, whereas for gardening (Female 44%; Male 32%; $p=0.001$) and stretching (Female 44%; Male 16%; $p<0.001$) the gender preference was reversed. Overall, 24% of patients experienced severe symptoms when performing at least one of their most important activities. Older patients experienced symptoms more than younger patients (26% vs 21%; $p<0.01$). As a whole, 93% of patients reported that they were satisfied with their knee post-operatively. However, satisfaction with TKA decreased significantly among patients who experienced severe or debilitating symptoms during of their most important activities, (at least one activity: 78% satisfied; $p<0.001$; during all 3 activities: 50%; $p<0.001$).

Discussion:

The New Knee Society Scoring System provides sufficient flexibility and scope to capture the diverse lifestyles and activities of contemporary TKR patients. Data collected by this assessment tool allow surgeons and affiliated personnel to appreciate differences in the priorities of individual patients and the interplay between function, expectation, symptoms, and satisfaction after TKR. A resounding conclusion of this new multi-dimensional analysis is that a critical factor in many patients' assessment of the value of this procedure is their restored ability to perform activities that they personally consider important.

5A : Knee mechanics: #893 September 21st, 2011, 16:20-17:10

Laboratory Testing Fails to Reproduce the Demanding Conditions Imposed on the Knee by Active Individuals

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Introduction:

Knee prostheses retrieved at revision often show patterns and severity of damage neither seen nor predicted from standard wear simulator testing. We hypothesized that this is because these implants are exposed to combinations of loads and motions that are more damaging than the simple loading profiles utilized in laboratory testing. We examined the magnitude, direction, and combination of forces and moments acting on the knee during various activities in order to guide the future development and testing of high-performance knee replacements.

Methods:

In vivo data from five patients with instrumented tibial implants were obtained from an open database (www.orthoload.com). We determined the direction and magnitude of forces and moments that the knee experiences during the following common physiologic activities: stair descent, stair ascent, deep knee bend, one leg stance, and walking. In order to capture the loading pattern, we investigated the three component forces and moments acting on the knee at several high demand points for each of these activities. The e-tibia data were compared to the loading profiles used in conventional laboratory testing (ISO 14243-1).

Results:

The vast majority of maximum forces and moments measured during these activities far exceeded those applied

during laboratory testing, often by several-fold (Table 1). Analysis of loading profiles showed considerable differences in the loading patterns both between individuals and activities. At the point of peak axial force during level walking, there were four distinct loading patterns in five patients- none of which matched the laboratory testing pattern. The comparison of the median loading pattern at the point of maximum axial force showed that each of the five activities generated distinct loading patterns, which all differed substantially from the loading pattern applied during conventional knee testing.

Discussion:

Current routines for laboratory testing of total knee joint prostheses fail to develop forces and moments of the magnitude present within knee prostheses and surrounding interfaces during physiologic activities. Moreover, the combinations of force and moment components generated during conventional testing differ fundamentally from those occurring in vivo. These discrepancies may explain the differences between the wear patterns seen in components retrieved at revision versus those generated by laboratory simulators. Clearly, new testing protocols imposing more severe loading conditions and variable loading patterns are required to simulate service conditions generated by more active patients and more diverse activities after TKR.

Figures

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Figure 2

A Novel Polycarbonate-Urethane Meniscal Implant: From Bench to First Clinical Experience

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Statement of Purpose:

Meniscal tears are common knee injuries that subsequently lead to degenerative arthritis, attributed to changes in stress distribution in the knee. In such cases there is need to protect the articular cartilage by repairing or replacing the menisci. While traditionally, meniscal replacement involves implantation of allografts, problems related to availability, size matching, cost and risk of disease transmission limit their use. Another optional treatment is that of biodegradable scaffolds which are based principally on tissue engineering concepts. The variability in body response to biodegradable implants and the quality of the tissue formed still pose a problem in this respect, under intense knee loading conditions. Moreover, biological solutions are mostly limited to younger patients <40 years old. Therefore, the goal of this study was, to develop a synthetic meniscal implant which can replace the injured meniscus, restore its function, and relieve pain.

Methods:

A composite, non-fixed self-centering discoid-shaped meniscus implant (NUsurafce®, AIC, Memphis, TN), composed of polycarbonate-urethane (PCU) and reinforced circumferentially with UHMWPE fibers is proposed (Fig. 1). The implant geometry was based on an extensive MRI study of over 100 knee scans [1]. The proposed structure aims to mimic the circumferential collagen reinforcement of the natural meniscus. Biomechanical evaluation of the implant was focused on in-vitro measurements of contact pressure under the implant in cadaver knees and computational finite element (FE) analyses [2,3]. Pressure distribution on the tibial plateau (under the meniscus implant) was measured by pressure sensitive films (Tekscan, MA) and quantified with respect to the natural meniscus. FE analyses were used to evaluate internal stress and strains, and to support the selection of

optimal implant configuration. The last pre-clinical step was a large-animal (sheep) study in which the cartilage condition was evaluated microscopically over six months [4].

Results:

Contact pressure distributions on the tibia, were in good agreement with those measured under the natural meniscus (Fig. 2). Specifically, peak and average pressures developed under the implant were found to similar to those of the natural meniscus. The contact area measured under the implant (658±135mm^2) was also restored when compared to the natural meniscus (642±96mm^2). FE models confirmed that internal strains/stresses within the device components remained within the materials' allowed limits. The evaluation of an implant adapted to sheep showed no signs of wear or degradation of the materials. Histology showed relatively mild cartilage degeneration that was dominated by loss of proteoglycan content and cartilage structure. First clinical results for the implant, with up to 2 years follow-up, demonstrate encouraging prospects for this concept in terms of pain relief.

Conclusions:

In the current study, we presented the development of a novel PCU meniscal implant for the medial compartment of the knee, along with an overview of essential tests. It was found that (a) the implant is able to reduce the overall cartilage load associated with meniscectomy by effectively distributing joint loads, and (b) the implant completely prevents contact between opposing cartilage surfaces. The results of implantation in sheep can be considered favourable in arresting joint degeneration, and first implantations have shown that arthroscopic implantation of the device is short and uncomplicated.

Figures

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Figure 1 HYPERLINK "http://app.istaonline.org/figures/464.jpg" \t "_blank"
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Figure 2

13B : Hip arthroplasty: #533 September 23rd, 2011, 11:15-12:05

Metal/polycarbonate-Urethane for Total Hip Reconstruction

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Introduction

Metal-on-polycarbonate urethane (MPU) is a cutting-edge new bearing technology for hip arthroplasty. The acetabular component consists of a 2.7mm-thick polycarbonate-urethane liner inserted into a specially manufactured uncemented titanium shell coated with hydroxyapatite [(HA) Fig.1]. The liner is pliable and biomechanically mimics human cartilage. In vitro studies have shown minimal wear, fluid film lubrication, physiological load transmission and shock absorption capacity equal to the normal hip. This system includes prosthetic heads of a diameter 12mm less than the socket diameter. The aim of this study was to clinically assess patients treated with this novel technology in a retrospective single centre study.

Methods

Twenty-seven patients with osteoarthritis treated with MPU bearing arthroplasty were included. Mean patient age was 67.9±10.35 years (44-84). Sixteen patients were female and 11 were male. Twenty-four of these had an uncemented HA-coated stem while 3 had a hip resurfacing metal femoral component. All patients were operated on by a single surgeon using a postero-lateral approach.

Results

No patients were lost to follow-up. Mean follow-up time was 29 months (minimum 24 months). There were no

major complications. At follow-up, the mean Harris hip score was 98 points (80-99). X-rays showed good bone-implant contact without any osteolysis or bone rarefaction.

Discussion and conclusion

Our promising short-term results confirm the in vitro findings. Advantages of this new bearing technology include the possibility to use large diameter metal heads without exposing the patients to elevated levels of metal ions as is the case with metal-on-metal bearings, the minimal wear and the superior biomechanical characteristics.

Figures

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Figure 1

Characterising 3D Soft Tissue Features on Joint Surfaces

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The various disorders of the patellofemoral joint, from pain syndrome to maltracking and arthritis, form a significant subset of knee disorders (Callaghan and Selfe 2007). Several studies have shown significant geography and gender based variation in incidence rates of these disorders and of osteoarthritis in general (Woolf 2003). A number of previous studies have examined patellar shape in this context, focusing primarily on the use of 2D measurements of bony geometry to classify patellar shapes and identify high-risk groups (Baumgartl 1964; Ficat 1970).

Recent developments in imaging and statistical analysis have enabled a more sophisticated approach, characterised by statistical shape models which account for three dimensional shape differences (Bryan 2008). Incorporating soft tissue data into these analyses, however, has been a challenge due to factors including the necessity of multi-modality images, absence of repeatable landmarks, and complexity of the surfaces involved. We present here a novel method which has potential to significantly improve analysis of soft tissue geometry in joints. It is built using Arthron, a UCD-developed biomechanics analysis software package.

The shape modelling process consists of three phases: pre-processing, consistent surface parameterization, and statistical shape analysis. The pre-processing phase consists of several mesh processing operations that prepare the input surfaces for shape modelling. Consistent surface parameterizations are implemented using the minimum description length (MDL) correspondence method (Davies 2002) [Fig. 1]. The statistical shape analysis phase involves the reporting and visualization of geometric variation at the input surface. An algorithm was developed to measure the cartilage thickness at each node on the patellar surface mesh. The initial step in this process was to calculate surface normal vectors at each point. These vectors were then projected through the cartilage surface model in order to calculate the thickness [Fig. 2]. The Matlab software was used to aggregate all cartilage thickness values in a given subgroup and after being normalised for the average patellar centroid size for the subgroup, these thicknesses were visualised on the average shape.

Pilot study data consisted of 19 Caucasian (7 female, 12 male) and 13 Japanese (7 female, 6 male) subjects. These data originated from studies performed by DePuy Orthopaedics Inc. Initial results show ethnicity effects in cartilage thickness to be more significant than gender effects [Fig. 3]. After correcting for patellar centroid size, male subjects display 9% greater average thickness than female subjects, while Caucasian subjects display 17% greater average thickness than Asian subjects. Areas of statistically significant differences ($t < 0.05$) were found to coincide with expected areas of patellofemoral contact through the flexion cycle, showing the potential for the thickness differential to impact upon patellar kinematics. Principal component analysis of the thickness distributions gives more detailed information about modes of variation.

With further development, this method has potential to enable sophisticated analysis of localised variation in soft tissue geometry, thereby improving understanding of the impact of joint geometry on disease formation.

Figures

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Figure 1 HYPERLINK "http://app.istaonline.org/figures/400.jpg" \t "_blank" INCLUDEPICTURE \d "http://app.istaonline.org/figures/400.jpg" * MERGEFORMATINET

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Figure 3

9B : Short stems: #569 September 22nd, 2011, 14:55-15:45

Experiences of Short Stem: Is Standard Stem Necessary in THA Using Tapered-Wedge Stem?

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Background:

Short stem has potential advantages of bone and muscle preservation. Current papers demonstrate that direct anterior approach (DAA) is a significant minimally invasive muscle-sparing approach to total hip arthroplasty. Theoretically, a short length stem with a reduced lateral shoulder is the most appropriate design for DAA.

Objectives:

To clarify the necessity of the standard length stem in tapered-wedge stem.

Patients and methods:

We prepared two kinds of tapered-wedge stem, Taperloc (standard length stem) and Microplasty (short stem) (Biomet, warsaw, Indiana) at the surgery. If the rasp for the short stem had not been fixed rigidly intra-operatively, it would have been changed to the standard length stem. Between May in 2010 and April in 2011, 94 patients (107 hips, 13 bilateral) were included in this study. All THAs were performed by direct anterior approach (DAA) on a standard surgical table. We analyzed the early clinical and radiographic results of 107 THAs in 94 patients (60 women, 34 men). The mean age was 61 (33~84) years. The mean height was 161 (142~182) cm and the mean weight was 63 (40~92) kg.

Results:

All hips were implanted with the short stem. There was no need of the standard length stem. The mean operative time was 54 (28-140) minutes and the mean operative blood loss was 422 (60~2400) ml. There was a significant improvement in functional outcome of these patients as measured by Japanese Orthopedic association hip scores. There were three complications intra-operatively or post-operatively. These were one intraoperative femoral fracture which was salvaged with circular wiring, one femoral fatigue fracture which occurred 6 weeks and cured conservatively, and one pulmonary embolism. There were no stem subsidence, dislocations and infections.

Conclusion:

This study confirms that there is no need of a standard length stem in THA using tapered-wedge stem. The short stem and DAA would be a winning combination for THA.

5A : Knee mechanics: #496 September 21st, 2011, 16:20-17:10

The Influence of the Tibial Slope on the Intra-Operative Soft Tissue Balance in Posterior-Stabilized Total Knee Arthroplasty

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Introductions

In cruciate-retaining total knee arthroplasty (TKA), among many factors influencing post-operative outcome, increasing the tibial slope has been considered as one of the beneficial factors to gain deep flexion because of leading more consistent femoral rollback and avoiding direct impingement of the insert against the posterior femur. In contrast, whether increasing the tibial slope is useful or not is controversial in posterior-stabilized (PS) TKA. Under such recognition, accurate soft tissue balancing is also essential surgical intervention for acquisition of successful postoperative outcomes in TKA. In order to permit soft tissue balancing under more physiological conditions during TKAs, we developed an offset type tensor to obtain soft tissue balancing throughout the range of motion with reduced patello-femoral(PF) and aligned tibiofemoral joints and have reported the relationship between intra-operative soft tissue balance and flexion angles. In this study, we therefore assessed the relationship between intra-operative soft tissue balance assessed using the tensor and the tibial slope in PS TKA.

Materials and methods

Thirty patients aged with a mean 72.6 years were operated PS TKA(NexGen LPS-Flex, Zimmer, Inc. Warsaw, IN) for the varus type osteoarthritis. Following each bony resection and soft tissue release using measure resection technique, the tensor was fixed to the proximal tibia and femoral trial prosthesis was fitted. Assessment of the joint component gap (mm) and the ligament balance in varus (°) was carried out at 0, 10, 45, 90 and 135degrees of knee flexion. The joint distraction force was set at 40lbs. Joint component gap change values during 10-0°, 45-0°, 90-0°, 135-0° flexion angle were also calculated. The tibial slopes were measured by postoperative lateral radiograph. The correlation between the tibial slope and values of soft tissue balance were assessed using linear regression analysis.

Results

Average joint component gaps were 11.2, 14.7, 16.7, 18.4 and 17.0 mm and ligament balance in varus were 2.2, 2.9, 5.3, 6.8 and 6.9°at 0, 10, 45, 90 and 135° of flexion, respectively. Average joint component gap changes were 3.5, 5.6, 7.2 and 5.7 mm at each range of motion between 10–0, 45-0, 90–0 and 135–0° of flexion, respectively. The mean tibial slope was 5.0(1.6-9.6) degrees. Joint component gap at 90 ($R = 0.537$, $p<0.01$),135($R=0.463$, $p<0.05$) degrees of flexion, and joint component gap change value of 90–0° ($R = 0.433$, $p<0.05$) showed positive correlations with tibial slope. The other factors assessed in this study showed no correlation with tibial slope.

Discussions

The joint gap toward mid-range of flexion might be measured at anterior part of the tibiofemoral joint, whereas the values of joint gap at high flexion where the femur shifted posterior due to femoral rollback were measured the widened posterior part of the joint gap. In addition, extensor mechanism as well as tibial slope might influence joint gap at deep flexion. In conclusion, even PS TKA, increasing the posterior tibial slope resulting in larger flexion gap compared to extension gap should be taken into account for the flexion-extension gap balancing.

6A : 3D planning and execution: #439 September 22nd, 2011, 8:30-9:35

3d Templating and Pre-Operative Planning for Total Knee Arthroplasty

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Remarkable strides made in medical technology and techniques of total knee arthroplasty over past 5 years. These changes have included: minimally invasive surgical techniques, pain management, navigation, kinematic design of prosthesis and recently custom fitted surgical guides based on the anatomic axis. To date, there has been little documentation of the use of these custom-cutting surgical guides.

There has been significant controversy as to the necessity of using the neutral alignment of the mechanical axis for this surgery for a long lived replacement. A recent study by Pagnano et al in 2008 demonstrated that it could not be confirmed that improvement in the mechanical axis to zero would lead to a long-term improvement in survivorship, and it was noted that there was actually a slight trend for the outliers to be more successful. A recent study (Three-Dimensional Morphology and Kinematics of the Distal Part of the Femur Viewed in Virtual Reality Eckhoff et al, JBJS 2005) provides kinematic and morphologic validation for a single cylindrical flexion-extension

axis of the knee. This fixed flexion-extension axis is best approximated by the axis of cylinders, fit to the circular posterior femoral condyles, and is designated the cylindrical axis of the knee.

An innovative surgical technique of total knee arthroplasty has been developed using MRI-based custom fitting cutting blocks. This technique advocates the use of an individual knee MRI, utilizes the cylindrical axis and proceeds with precise measurements of the arthritic knee. Proprietary software creates a 3-dimensional model of the knee and then corrects the deformity virtually, and recreates the knee's pre-arthritic alignment. Guides are designed to fit on diseased bone and set transverse resection and rotation and enable implant placement that restores joint to pre-disease position.

32 patients were enrolled in this IRB-approved study of total knee replacement. Pre-operative standing anterior-posterior lower extremity x-rays were required for assessment of the degree of malalignment. Patients with a malalignment greater than 15 degrees were excluded from the study. Only 26 knees with varus alignment were in the final study group since the valgus group was very small in number. Computer navigation appears to provide the most precise kinematic measurement of the knee, and was used during the operation to assess and quantitate the pre-operative, intra-operative, and post-operative alignment and potential correction. The pre-operative pathologic malalignment was documented by navigation and the post-operative alignment did demonstrate some correction of this malalignment back to the presumed pre-arthritic alignment.

Change in alignment of 26 varus knees was documented as the following: Pre-op AP standing XRay: average 6.9 degrees varus; Pre-op Navigation : average 6.3 degrees varus; Post-op Navigation: average 3.4 varus degrees. This resulted in post-operative correction of the varus knee to 2.9 degrees.

Documentation of resections planes was noted as the following: Femur AP Resection 3.0 degrees valgus (r: 3.5 varus-4.0 valgus); Femur Distal Resection: 3.7 degrees flexion (r: 2.5 ext-10.0 flex); Femur Rotation Resection: 3.6 degrees internal rotation (r: 2.5 ext-7.5int); Tibia AP Resection 3.3 degrees varus (r: 2.0 valgus-6.0 varus); Tibia Slope Resection: 3.7 degrees posterior (r: 0.5 ant-9.0 post).

This study did support the premise that custom-fitting surgical guides locate the cylindrical axis, as determined by Eckhoff et al. This may provide the patient with less soft tissue stress and allowing a quicker return to function as reported in earlier studies. This surgeon did recognize obstacles using the custom-fitting surgical guides including determining the extent of debridement of soft tissue and osteophytes to allow appropriate capture of the blocks, as well as the risk of PCL injury. Navigation can be used as a training tool to aid in the prevention of significant error.

By locating the cylindrical axis, the natural kinematics of the knee are addressed, including the soft tissue tension. As the mechanical axis is being challenged, we look to the cylindrical axis as our potential objective, unique for each patient. Further validated studies are required, to understand the operative kinematics and the long term effects of the cylindrical axis.

8B : Bearings - hip: #481 September 22nd, 2011, 13:55-14:45

The Effect of Alumina Ceramic Femoral Head Size in Wear Against Highly Cross-Linked Polyethylene Acetabular Cup

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Different types of highly cross-linked polyethylene (HXLPE) have been introduced widely in acetabular cups in hip prostheses to reduce the incidence of wear debris-induced osteolysis. Also, we reported that HXLPE cups with 28-mm alumina ceramic femoral head exhibited lower wear than conventional PE cups. Recently, the combination of HXLPE cup and larger diameter femoral head is used widely to prevent dislocation. In this study, we examined the wear of HXLPE with 32-mm alumina ceramic femoral head and compared it with the wear of HXLPE with 28-mm alumina ceramic femoral head.

The in vivo wear of 60 HXLPE cups (Aeonian; Kyocera Corp., Kyoto, Japan, currently Japan Medical Materials

Corp., Osaka, Japan) with 28-mm alumina ceramic femoral head with clinical use for 3.1–9.1 years (mean 7.4 years) and eight HXLPE cups with 32-mm alumina ceramic femoral head used for 2.3–3.2 years (mean 2.8 years) were examined by radiographic analysis.

The early wear rate for the first year of HXLPE cups with 28-mm and 32-mm alumina ceramic femoral head were 0.24±0.10 mm/year and 0.29±0.12 mm/year respectively. There was no significant difference in both femoral head groups ($p>0.05$). The steady wear rate after 1 year were 0.001±0.03 mm/year and -0.03±0.10 mm/year respectively. There was no significant difference either in both femoral head groups ($p>0.05$).

These findings from this radiographic analysis suggest that the early wear rate in the first 1 year probably represents the creep deformation in bedding-in stage; and the steady wear rate after 1 year probably represents mainly the wear than of the creep deformation. By the radiographic analysis, HXLPE cups in both femoral head groups exhibited low steady wear rate.

In conclusion, we expect that the combination of HXLPE cup and 32-mm diameter alumina ceramic femoral head has favorable wear properties with possibility of prevention of dislocation in long-term clinical use.

Plenary session 2 : Award Session: #1111 September 22nd, 2011, 9:45-10:30

Novel Active Stabilization Technology in Highly Crosslinked UHMWPEs for Superior Stability

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Radiation cross-linked ultrahigh molecular weight polyethylene (UHMWPE) is the bearing of choice in joint arthroplasty. The demands on the longevity of this polymer are likely to increase with the recently advancing deterioration of the performance of alternative metal-on-metal implants. Vitamin E-stabilized, cross-linked UHMWPEs are considered the next generation of improved UHMWPE bearing surfaces for improving the oxidation resistance of the polymer. It was recently discovered that in the absence of radiation-induced free radicals, lipids absorbed into UHMWPE from the synovial fluid can initiate oxidation and result in new free radical-mediated oxidation mechanisms. In the presence of radiation-induced free radicals, it is possible for the polymer to oxidize through both existing free radicals at the time of implantation and through newly formed free radicals *in vivo*. Thus, we showed that reducing the radiation-induced free radicals in vitamin E-stabilized UHMWPE would increase its oxidative stability and presumably lead to improved longevity. We describe mechanical annealing, low pressure annealing, and warm irradiation of irradiated vitamin E blends as novel methods to eliminate 99% of radiation-induced free radicals without sacrificing crystallinity. These are significant improvements in the processing of highly cross-linked UHMWPE for joint implants with improved longevity.

1B : MIS - Hip: #677 September 21st, 2011, 8:30-9:35

Modified Minimally Invasive Two-Incision THA Using Large-Diameter Metal-on-Metal Articulation in Patients With Muscle Weakness

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Purpose:

Hip arthroplasty is a good treatment option for displaced femoral neck fracture in elderly patients. However, neuromuscular disease such as cerebral infarction or hemorrhage can be a concerning problem for THA since

dislocation after operation can frequently occur. The purpose of this prospective study was to evaluate the functional results of modified minimally invasive (MI) two-incision total hip arthroplasty (THA) with the use of large-diameter (>38mm) metal-on-metal articulation in patients with muscle weakness.

Patients and Methods:

19 consecutive patients (19 hips) with displaced femoral neck fracture with muscle weakness were enrolled. There were 11 patients with cerebral infarction, 4 patients with cerebral hemorrhage and 4 patients with Parkinson's disease. In the lateral position, an anterolateral approach between the gluteus medius and tensor fascia lata and a posterior approach between the piriformis and gluteus medius were used.

Surgical morbidity, functional recovery, radiological implantation properties, range of motion (ROM) and complications were assessed.

Results:

The mean operation time was 73.5 minutes and the average perioperative blood loss was 725.9cc. The mean head diameter used was 44 mm (38-50). The mean lateral opening angle of the acetabular component was 38.4°, the mean anteversion of the acetabular component was 16.4°, and the mean stem position was 0.3° valgus. The average postoperative ambulation time was 2.4 days. The mean Harris hip score was 81.0 at final follow-up, and the mean WOMAC score was 42.9. At final follow-up, there was no case of dislocation. There was no hypersensitivity, no osteolysis, and no revision.

Conclusions:

Our study suggests that the functional results of modified MI two-incision THA with the use of large-diameter metal on metal articulation in patients with muscle weakness can produce satisfactory early functional recovery and can reduce the dislocation rate.

Total Hip Arthroplasty Conversion After Previous Transtrochanter Rotational Osteotomy for Osteonecrosis of the Femoral Neck

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Purpose:

The purpose of this study is to know the peri-operative morbidity, clinical and radiographical outcomes of conversion THA from failed transtrochanter rotational osteotomy (TRO).

Patients and methods:

From 2003 January to 2009 January, there were 18 hips(18 patients) who underwent conversion THA from TRO for osteonecrosis of the femoral head (ONFH) (Group I). The mean duration from TRO to conversion THA was 2.6 years. We made a matched control group of 18 primary THA for ONFH (Group II) and we evaluated perioperative morbidity and complications in each group. For the clinical evaluation, we checked Harris hip score (HHS) and WOMAC score. For the radiographical evaluation, we evaluated implant position, stability and osteolysis.

Results:

There was no significant difference in operation time, blood loss, or hospital stay between two groups. In clinical results, there was no significant difference in postoperative HHS ($p=0.986$), but there was significant difference in postoperative WOMAC score. There was more significant postoperative internal rotation limitation in the Group II ($p<0.001$). In radiographical evaluation, there was no significant difference between two groups, except the

preoperative leg length discrepancy (p=0.015)

Conclusion:

According to our study, there was no significant difference between conversion THA after TRO and primary THA in terms of perioperative morbidity and radiographical out come. But primary THA showed better postoperative internal rotation and better WOMAC score than conversion THA after previous TRO for ONFH.

7A : MIS - UNI knee: #776 September 22nd, 2011, 11:15-12:05

Comparative Study Between MIS QS and Mini Quadriceps Incision TKA in Asian

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Introduction:

Patient demand for a less invasive surgical approach reducing the trauma induced to the joint has resulted in the development of Minimally Invasive Surgery (MIS). Although the length of the surgical incision is appealing to patients, the changes are not purely cosmetic. The surgery should not violate the extensor mechanism in any way. Incisions into the quadriceps tendon or into the vastus medialis muscle make the approach less difficult but this violation will slow the recovery and affect the ROM of the knee. In Asian knees, authors found the variation of VMO, which is essential in early functional recovery in TKA patient, is so much, so new clinical test for MIS QS should be needed to show location relationship between the upper pole of the patella and the insertion of VMO itself to avoid unnecessary injury of VMO during TKA.

Purpose:

The purpose of this comparison study was to verify whether MIS QS TKA can be a more functional and better method in treatment of advanced degenerative arthritis comparing with mini MIS TKA.

Methods:

Group I: MIS QS group were 50 knees (69.3±9.7 years) and follow up period of that were 28.8± 0.4 months. Group II: mini quad split MIS TKA were 200 knees knees (67.4±5.6 years) and follow up period of that were 34..2± 0.6 months. We did clinical and radiological assessment.

Results:

The length of incision of group I was 9.32±0.96 cm and that of group II was 10.9±0.5 cm. In clinical assessment, the postoperative pain score of group I was 47.5±2.74 points and that of group II was 47.4±3.27 points. The postoperative knee score of group I was 94.5±5.16 points and that of group II was 93.9±5.94 points. The postoperative knee functional score of group I was 90±8.94 points and that of group II was 93.4±6.73 points. The postoperative range of motion of group I was 122±16.9 degrees and that of group II was 116±23.5 degrees. In radiological assessment, The postoperative tibiofemoral angles of group I was 5±2.6 degrees and that of group II was 5.4±2.7 degrees. The α and β angle of group I was 95±3.5, 88±3.4 degrees and that of group II was 96±2.5, 89±2.4 degrees. The γ and δ angle of group I was 5.17±4.12, 85±1.4 degrees and that of group II was 3.96±3.1, 86±1.8 degrees.

Conclusions:

There were no significant differences in functions between two groups. Both MIS QS and mini Quad split TKA are an effective and safe method in treatment of advanced degenerative arthritis.

13A : Robotics & navigation: #778 September 23rd, 2011, 11:15-12:05

A Comparative Study of Robotic-Assisted and Manaual Implanatation of Total Knee Arthroplasty

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Introduction:

Recently robotic-assisted total knee replacement has become a new emerging method of artificial joint implantation, especially in Europe and Asia. We have belived that robotic cutting would result in an improved clinical outcome due to the better fit and alignment of the prosthesis but that has never been proven to our knowledge. The purpose of this study was to compare robotic-assisted implantation of a total knee replacement

with conventional manual implantation.

Methods:

We reviewed 72 patients who were scheduled for total knee arthroplasty, divided to have either conventional manual implantation of a Zimmer LPS prosthesis (30 patients: Group I) or robotic-assisted implantation of such a prosthesis (32 patients: Group II). The five-axis ROBODOC was used for the robotic-assisted procedures. Radiographs were made at this interval and analyzed for evidence of loosening, prosthetic alignment, and other complications. Independent T-test or Mann-Whitney test was used for statistical analysis at probability level of 95%. SPSS for Windows was used.

Results:

The age of group I was 67.8±6.44 years and that of group II was 62.7±6.51 years. The follow up period of group I was 31.3±3.47 months and that of group II was 27.0±0.69 years. In clinical assessment, there was no difference statistically. In radiological assessment, the postoperative tibiofemoral angles of group I was 5.3±2.6 degrees and that of group II was 6.0±1.8 degrees. There was no difference statistically. The α and β angle of group I was 95.6±2.65, 88.6±2.58 degrees and that of group II was 97.7±0.97, 88.8±1.59 degrees. There was no difference statistically. The γ and δ angle of group I was 4.19±3.28, 85.5±0.92 degrees and that of group II was 0.17±0.65, 89.7±1.7 degrees. There was a significant statistical difference($P<0.05$). The complications were observed in Group II: 1 superficial infection, 1 patellar tendon rupture, 1 postoperative supracondylar fracture and 1 peroneal nerve palsy.

Discussion:

The robotic-assisted technology had definite advantages in terms of preoperative planning, the accuracy of the intraoperative procedure and postoperative follow up in lateral knee radiograph, especially in γ and δ angle. But disadvantages were the high complication rate, which we believe was required for the more careful and experienced operative technique. We need further kinematical study about the clinical importance of γ and δ angle in TKA patients, especially wear pattern etc before robotic popular usage in USA.

11A : Knee kinematics: #866 September 22nd, 2011, 17:40-18:30

In Vivo Comparative Kinematic Analysis of TKA Versus the Non-Implanted Contralateral Knee for the Same Subject

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Mathew Anderle - University of Tennessee - Parker, USA
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Introduction:

Previous fluoroscopic studies compared total knee arthroplasty (TKA) kinematics to normal knees. It was our hypothesis that comparing TKA directly to its non-replaced controlateral knee may provide more realistic kinematics information. Using fluoroscopic analysis, we aimed to compare knee flexion angles, femoral roll-back, patellar tracking and internal and external rotation of the tibia.

Material and methods:

15 patients (12 women and 3 men) with a mean age of 71.8 years (SD=7.4) operated by the same surgeon were included in this fluoroscopic study. For each patient at a minimum one year after mobile-bearing TKA, kinematics of the TKA was compared to the controlateral knee during three standardized activities: weight-bearing deep-knee bend, stair climbing and walking. A history of trauma, pain, instability or infection on the non-replaced knee was an exclusion criteria. A CT-scan of the non-replaced knee was performed for each patient to obtain a 3-D model of the knee. The Knee Osteoarthitis Outcome Score (KOOS) was also recorded.

Results:

Active flexion was significantly higher in the TKA group with a weight-bearing flexion averaging 103.4° and a passive flexion 133°, and respectively 96.4° and 135° for the contro-lateral knee. Twelve TKA patients out of 15

showed a higher flexion than their contro-lateral knee. The extension was also singificantly higher in the TKA group than in their contro-lateral knee (-4.8° versus -1.8) (p=0.0095). The axial rotation was significantly higher in the non-replaced knees than in the TKA group with respectively 18.7 ° versus 8.9° (p=0.0005). The position of the femorotibial contact point during the arc of flexion was significantly more posterior for the non-replaced knees compared to the TKA. The tracking of the patella showed significantly less lateral tilt for the TKA. KOOS scores were comprised between 70 and 100 but none of the patient did consider the replaced knee as a forgotten knee.

Discussion and conclusion:

The results of our study demonstrated that TKA may restore the arc of flexion with a better patellar tracking even if kinematics parameters of TKA are not directly comparable to the contro-lateral knees. This kinematics differences may explain why despite very good specific quality of life and functional score, none of the patient considered his/her replaced knee as a forgotten knee.

4B : Hip resurfacing: #727 September 21st, 2011, 14:50-15:40

Hip Resurfacing Arthroplasty at a Non-Specialist Centre: Clinical and Radiological Follow-Up of 5 Years

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Background

There is much research on metal on metal hip resurfacing arthroplasty (HRA) but few studies have reported the outcome with respect to implant characteristics from non-specialist centres.

Aim

To report the survival, clinical and radiological outcomes of a single surgeon series of HRA with an average follow-up of 5 years.

Methods

All consecutive HRAs performed by a single surgeon between 2002- 2010 at a district general hospital were examined clinically and radiologically. The median follow-up was 61 months (12-102). Clinical assessment included the Oxford Hip Score (OHS) and University of Los Angeles (UCLA) Activity Score. Radiological assessment included implant position and various bony changes. Survival was defined as a need for revision of either component.

Results

There were 75 HRA procedures (59 patients): 70 Birmingham, 2 Conserve, 2 Adept and 1 ASR. The median age was 58 years (25-75) with 46.7% (35) male and 53.3% (40) female. 4.2% (3) patients were lost to follow-up. The mean acetabular and femoral implant sizes were 54.8mm (48-64) and 48.2mm (42-58) respectively. The mean acetabular and femoral inclination angle was 45.4° (20.8-75.2°) and 138° (133-149.5°) respectively. Survival rate was 92% with 6 revisions due to aseptic loosening (3) and fracture (3). These failures were all predominantly female (5) with significantly smaller mean acetabular (50mm, p=0.036) and femoral (43.3mm, p=0.038) implant sizes. Moreover, they had a higher mean acetabular inclination angle of 47.8° (p=0.27). The mean OHS was 43.5 (25-48) and the mean UCLA activity score was 6.7 (3-10). Radiological findings included heterotopic ossification in 21.6% (16), radiolucent lines in 6.8% (5), femoral neck thinning in 2.7% (2) and notching in 5.4% (4).

Discussion

HRA has been shown to have comparable clinical and radiological short-medium term outcomes in a non-specialist centre using different implants. Failed procedure rate is high and patients were predominantly female, with significantly smaller implants and a higher acetabular inclination angle. Vigilance is therefore required in case selection and in follow-up for such patients.

2A : CAOS session: #746 September 21st, 2011, 11:15-12:05

Should Preoperative Deformity Determine Femoral Component Rotation in Total Knee Arthroplasty?

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Introduction:

Most surgeons utilize one of three axis options in conventional total knee arthroplasty (TKA), the transepicondylar axis (TEA), Whiteside's line (WSL) or the posterior condylar axis (PCA) with an external rotation correction factor. Each option has limitations and no clear algorithm has been determined for which option to use and when. Many surgeons believe the TEA to be the gold standard for determining rotation however it can be difficult to access intraoperatively. WSL and PCA have been used as surrogates for determining axial rotation in conventional TKA but may also be prone to error. MRI based preoperative planning systems overcome intraoperative limitations while accounting for the individual anatomy of each patient, thus helping optimize femoral component rotation. The goal of this study was to examine if coronal plane deformity had any effect on the relationship of conventional referencing options such as WSL and PCA to the TEA.

Methods:

Utilizing a preoperative planning software based on MRI, we compared the preoperative posterior femoral condyle resections for three different axis options in 176 TKA. The difference in bone resection amount was used to determine the rotational differences between the axis options in all knees. Assuming that the TEA was the ideal rotational axis, we compared the TEA to both WSL and PCA. A 1-sample t-test and paired t-test were then used to determine if there was a significant rotational difference between the various axis options when accounting for degree and direction of preoperative deformity in the coronal plane.

Results:

In the overall population of 176 knees (42 valgus, 134 varus), neither WSL or PCA approximated the TEA accurately (p=0.016 and 0.001). In valgus deformity, WSL was found to approximate the TEA (p=0.68) better than the PCA (p=0.21). Minor varus deformity (< 3 degrees) favored the use of PCA (0.53) while moderate varus deformity (3-6 degrees) favored use of WSL (p=0.76). Severe varus (>6 degrees) deformity favored use of PCA due to lower variability. For complete results see Figure 2.

Conclusion:

Based on MRI data, our study indicates that preoperative coronal plane deformity should help determine the specific referencing option utilized for femoral component rotation in TKA. Broad application of either WSL or the PCA to all patients regardless of preoperative deformity did not accurately approximate TEA in femoral component rotation. Rather, analysis of the degree and direction of preoperative coronal plane deformity indicates that WSL and PCA should be used in specific scenarios to approximate the TEA. When WSL or PCA either both approximate or do not approximate the TEA, we recommend using the option with a lower standard deviation, and thus less variability. Although this MRI based technology is not in widespread use, we believe our findings (Figure 1) can assist the majority of surgeons determine when to use WSL or the PCA based on preoperative coronal plane deformity.

Figures

3B : Hip mechanics: #1041 September 21st, 2011, 13:50-14:40

Variation in Contact Areas in the Proximal Femur Depending on Implant Design

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Introduction

Many uncemented femoral implant designs have had successful outcomes in total hip arthroplasty (THA). Different uncemented stem designs achieve initial and long term stability through shape, size, coating and fit. There is increasing emphasis on bone preservation, particularly in younger and more active patients. The desire to optimize load transfer has led to the development of short stems that seek to achieve fixation in the proximal femur. Short stems designed to achieve stability by engaging the metaphysis or the proximal femoral necks are currently in clinical use. The purpose of this study was to examine the extent to which five stems designed to achieve proximal fixation contact the bone in the proximal femur. Using three-dimensional CT models of 30

femurs, we assessed the fit, fill and contact of each of the five different implants.

Methods

Using three-dimensional computerized templating software designed to navigate robotic surgery, pre-operative CT scans of 30 patients were analyzed. Each of five femoral implant designs (TRILOCK, ARC, ABGII, CITATION, ACCOLADE) was then optimized for size and fit based on manufacturer technique guide and design rationale. The proximal femoral metaphysis was divided into four zones in the axial plane. Five contact points were determined on the frontal plane using anatomical landmarks. Each zone was assessed for cortical contact and fill of the bone-implant interface. We graded contact from 1 to 5, with 5 being 100% contact.

Results

In the 150 different templates analyzed significant variability existed in contact areas of the proximal femur depending on implant design and femoral morphology. High femoral neck resection design (ARC) had the greatest contact area in the most proximal zones (Figure 1). The ABG II and Trilock stems had comparable contact in the antero-medial zones, while the ABG II had greater fill in the sagittal plane (Figures 2 & 3). The Trilock was the only stem that consistently achieved lateral cortical contact at the distal landmarks. All stems showed a pattern of mostly posteromedial contact proximally and mostly anteromedial distally.

Discussion

To our knowledge, this is the first study to examine the contact points of metaphyseal engaging stems in the proximal femur. By directly comparing implant contact points in the same femur we found significant variability in the extent of fit, fill and contact of the metaphysis. These differences in proximal femoral contact are like to have implications for fixation in bone of varying quality and for long term proximal bone remodeling.

Figure 1. ARC implant (high femoral neck resection) size 1 shows good proximal medial contact (yellow arrow), but lacks contact at the level of the lesser trochanter (red arrow).

Figure 2. ABGII implant templated to a size 3 stem with good contact throughout the medial aspect of the metaphysis (yellow arrows).

Figure 3. Trilock standard neck stem templated to size 0. Again good cortical contact is appreciated along the medial aspect of the proximal metaphysis (yellow arrow).

Figures

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Figure 3

2B : Patient management: #435 September 21st, 2011, 11:15-12:05

Wound Complications in Joint Arthroplasty: Evaluation of a Unidirectional Barbed Suture for Skin Closure

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Introduction:

Joint reconstruction remains a successful and popular surgery with advances in approaches, implants and techniques continually forthcoming. Various methods of skin closure exist to address issues in efficiency, aesthetics, and barrier to infection. While subcuticular skin closure techniques offer an aesthetic advantage to conventional skin stapling, no measurable differences have been reported. Furthermore, newer barbed sutures,

such as the V-loc absorbable suture, *theoretically* distribute tension evenly through the wound and help decrease knot-related complications. To our knowledge, no literature exists on the rate of wound complications in joint arthroplasty with the use of V-loc suture for skin closure. We hypothesize that despite theoretical gains, skin closure with a V-loc (Covidien, Mansfield, MA) absorbable suture should be performed with caution.

Methods & Materials:

A retrospective chart review was conducted of 278 consecutive primary joint reconstruction cases performed by a single surgeon in 12 months from July 2009 through June 2010. Pre-operative history & physical reports were evaluated for co-morbidities (i.e diabetes mellitus), smoking status and body mass index (BMI). Operative dictations by the attending surgeon provided information on the surgical procedure, use of drain, wound closure technique and type of suture/staple used for skin closure. Skin was closed by the primary surgeon and his chief resident. Wounds were closed via staple gun or subcuticular stitch (3-0 Biosyn vs V-Loc) in a consecutive manner, depending on the surgeon's preference in that period. Post-operative clinic notes were reviewed to determine the occurrence of wound complications, issuance of antibiotic prescriptions, or return to the operating room. The cohort consisted of 106 males and 161 females at an average age of 63 years (range: 18-92). Overall, there were 153 procedures at the knee (including TKA, uni-compartmental arthroplasty, patello-femoral arthroplasty) and 125 procedures at the hip (including THA and hemi-arthroplasty).

Results:

In review of 278 consecutive primary joint reconstruction cases, there were 17 (6.1%) post-operative wound complications noted, including cellulitis, stitch abscesses, wound dehiscence, and deeper infections requiring OR irrigation and debridement. In 181 cases, staples were used for skin closure; in these cases, seven wound complications were noted (7/181, 3.9%). In 49 cases closed via a subcuticular Biosyn suture there were 4 wound complications noted (4/49, 8.1%). Six wound complications occurred in cases closed with a V-loc suture (6/45, 13.3%).

Discussion:

Aesthetics and efficiency often are the driving forces of innovation. We present the rate of wound complications in various superficial wound closure methods, including the V-loc, an innovative absorbable barbed suture. Based on our clinical experience, we promote consideration of wound and infectious complications when choosing a method of skin closure in joint reconstruction procedures.

6B : Survival / Outcome: #636 September 22nd, 2011, 8:30-9:35

The Socioeconomic Impact on Patient Based Outcomes and Satisfaction After Total Hip and Knee Arthroplasty

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Introduction:

It is thought that socioeconomic status and cultural upbringing influence the patient based outcomes of total joint arthroplasty. Previous studies have shown that patients in a lower socioeconomic class had surgery at an earlier age, increased comorbidities, increased severity of symptoms at presentation, and less satisfaction with the outcome. The purpose of this study was to compare the 1) reasons for undergoing total joint replacement and 2) satisfaction with the outcome among patients in different cultures and socioeconomic categories. We hypothesized that the overall reasons for undergoing surgery would be similar among all groups.

Method:

Patients undergoing total hip or knee arthroplasty were divided into groups based on their country of residence and socioeconomic status. The patients were asked to rank their reasons for undergoing surgery preoperatively from 1 to 4 according to importance. They were also asked to state how much relief of pain or improvement in function they expected to obtain. They were then asked to complete a questionnaire assessing their satisfaction

with surgery 6 months post-operatively. These results were then compared across the three groups..

Results:

Thirty Nepalese patients and 10 American patients who received total hip or knee arthroplasty as part of a charitable outreach program were compared with 20 age and sex matched American patients who electively underwent total hip or knee arthroplasty. In both the Nepalese and outreach American patients, pain relief followed by improvement in performing everyday actions were listed as the most important reasons for undergoing surgery. The control group of American patients who sought surgery electively listed pain relief followed by improvement in performing individual activities as the main reasons for undergoing surgery. As compared to the other groups, the elective patients ranked athletic improvement higher as a reason for undergoing surgery. A review of the post-operative questionnaires completed by the Nepalese and American outreach patients showed that all were satisfied with the outcome of surgery and reported improvement in pain and the ability to perform individual as well as everyday activities. The postoperative questionnaires completed by the elective American patients showed satisfaction with the surgery, however, they reported less improvement in all functional categories.

Conclusion:

We found that, despite socioeconomic status, the reasons for undergoing total joint arthroplasty were similar among all groups. Pain relief was the most important reason for having surgery. There was a tendency for elective patients to rank participation in athletic activities higher than those in the lower socioeconomic groups. All patients were satisfied with their outcomes. However, the degree of subjective improvement among elective patients was less than that in lower socioeconomic groups. This may be due to the fact that, due to their lack of access to care, patients in lower socioeconomic groups had more severe disease prior to surgery.

1A : Kinematics and Wear-knee: #899 September 21st, 2011, 8:30-9:35

Wear Comparison of Titanium Tibial Trays to Cobalt Chrome Tibial Trays

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INTRODUCTION:

Many studies have looked at the effects of titanium tibial baseplates compared to cobalt chrome baseplates on backside wear. However, the surface finish of the materials is usually different (polished/unpolished) [1,2]. Backside wear may be a function not only of tray material but also of the locking mechanism. The purpose of this study was to evaluate the wear performance of conventional polyethylene inserts when mated with titanium tibial trays or cobalt chrome tibial trays that both have non-polished topside surfaces.

MATERIALS AND METHODS:

Three titanium (Ti) trays were used along with three cobalt chrome (CoCr) trays. The Ti trays underwent Type II anodization prior to testing. All trays were Triathlon® design (Stryker Orthopaedics, Mahwah, NJ). Tibial inserts were manufactured from GUR 1020 conventional polyethylene then vacuum/flush packaged and sterilized in nitrogen (30 kGy). Appropriate sized CoCr femoral components articulated against the tibial inserts (Triathlon®, Stryker Orthopaedics, Mahwah, NJ).

Surface roughness of the tibial trays was taken prior to testing using white light interferometry (Zygo Corp, Middlefield, CT). A 6-station knee simulator (MTS, Eden Prairie, MN) was used for testing. Two phases were conducted. The first phase used a normal walking profile, as dictated by ISO 14243-3 [3]. The second phase used waveforms created specifically for stair climbing kinematics. Testing was conducted at a frequency of 1 Hz for 2 million cycles for each test with a lubricant of Alpha Calf Fraction serum (Hyclone Labs, Logan, UT) diluted to 50% with a pH-balanced 20-mMole solution of deionized water and EDTA (protein level = 20 g/l) [4]. The serum solution was replaced and inserts were weighed for gravimetric wear at least every 0.5 million cycles. Standard test protocols were used for cleaning, weighing and assessing the wear loss of the tibial inserts [5]. Soak control specimens were used to correct for fluid absorption with weight loss data converted to volumetric

data (by material density). Statistical analysis was performed using the Student's t-test ($p<0.05$).

RESULTS:

White light interferometry measurements (Figure 1) showed a significant difference in surface roughness between the Ti and CoCr tibial trays ($p < 0.01$). Figure 2 displays the results of wear testing after 2 million cycles for walking and stair climbing kinematics and showed no significant difference in wear rate between the two tibial trays for either test. The large standard deviation for the CoCr trays during stair climbing kinematics is due to one outlier that had 60% higher wear than the remaining two stations. Without this station, the average of the remaining two CoCr stations was 7.6 mm^3/mc, which was similar to the average obtained using Ti tibial trays. Figure 3 shows the backside surfaces of the polyethylene inserts after 2 million cycles using the stair climbing kinematics. Visually, the inserts mated with the Ti trays showed less of a stenciling effect that those mated with CoCr trays. The location of the stenciled area corresponded to the location of the femoral condyle during the loading cycle.

DISCUSSION:

Although Ti has different material properties than CoCr, the results of this study show that the wear performance was not adversely affected when Ti tibial trays were substituted for standard CoCr tibial trays under normal walking and stair climbing kinematics. Even though there are differences between the two materials, the documented wear was not significantly different possibly owing to the specific locking mechanism tested.

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Figures

2B : Patient management: #900 September 21st, 2011, 11:15-12:05

Staphylococcus Sp. Adhesion to Barrier Layer-Modified Titanium Alloy

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INTRODUCTION:

Biomaterial-related infections are an important complication in orthopaedic surgery [1], and *Staphylococcus sp.* accounts for more than half of the prosthetic joint infection cases [2]. Adhesion of bacteria to biomaterial surfaces is a key step in pathogenesis of such infections [3]. Titanium alloys are widely used in orthopaedic implants because their biocompatibility [4]. Surface incorporation of ions with antimicrobial properties, like fluorine, is one strategy previously studied with good results [5].

MATERIAL AND METHODS:

A 18mm diameter rod of Ti–6Al–4V alloy ELI grade according to the standard ASTMF136-02 supplied by SURGIVAL was cut into 2 mm thick disk specimens, ground through successive grades of SiC paper to 1200 grade, degreased with a conventional detergent and rinsed in tap water followed by deionised water. The specimens were then chemically polished (CP).

The disks were anodized only on one side by using a two electrode cell in a suitable electrolyte. TiO_2 barrier layers, without fluoride (BL), were produced by anodizing in 1 M H_2SO_4 at 15 mA cm-2 to 90 V, reaching 200 nm of thickness.

Fluoride barrier layers (FBL) were produced in an electrolyte containing 1 M $NH_4H_2PO_4$ and 0.15 M NH_4F, at constant voltage controlled at 20 V for 120 min at 20ºC; the thickness of the layer is 140 nm.

Laboratory biofilm-forming strains of *Staphylococcus aureus* 15981 [6] and *Staphylococcus epidermidis* ATCC 35984 were used in adherence studies, which were performed using the protocol by Kinnari et al [7]. Photographs obtained were studied by ImageJ software. Statistical analysis was performed by EPI-INFO software. The experiments were performed in triplicates

RESULTS:

Lower adherence was detected when compared FBL with unmodified controls (CP and BL). A statistical significant difference ($p<0.01$) was detected in the adhesion to modified material between both species, being the adherence of *S. aureus* lower than that of *S. epidermidis* (Figure 1).

DISCUSSION & CONCLUSIONS:

There is currently a discussion about the actual antibacterial properties of fluorine when incorporated in biomaterial surfaces. In this study we have demonstrated that both *S. aureus* and *S. epidermidis* strains showed a decrease of bacterial adhesion to modified surfaces with fluorine, a decrease that cannot be due to other surface modifications. Further studies, including adhesion studies with clinical strains [8], must be performed to confirm these results, which can lead to the development of new materials with a potential use in orthopaedic surgery.

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ACKNOWLEDGEMENTS: This study was financed by CONSOLIDER FUNCOAT-CSD2008-00023.

Figures

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Figure 2

Fingerprinting Total Knee Arthroplasty to Characterize Surgical Variability: A Numerical Study

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Introduction

We introduce the concept of total knee arthroplasty (TKA) fingerprinting as a tool to characterize and graphically convey the sensitivity of a TKA design to surgical variability in implant component position and patient-related anatomic factors. Identifying sensitive directions preoperatively which would cause undesirable effects may decrease revision surgery by informing surgical decisions and planning. To provide several examples of TKA fingerprinting, we estimated and compared the contact forces in a single TKA type for several configurations, simulating surgical variability and patient-related anatomical factors during a loaded deep squat. The purpose of this study is not to analyze the behavior of this specific TKA design but rather to illustrate a tool that could be used to show, in general, how surgical errors or anatomical factors can alter patello-femoral (PF) and tibio-femoral (TF) contact forces compared to its own reference configuration.

Materials and methods

Computed tomography images of one full cadaveric leg were used to generate 3D models of the bones and to obtain a physiological knee model assuming standard positions of the main soft tissue insertions.

A fixed bearing posterior stabilized knee TKA design was considered in this study. The prosthesis was a medium size, replaced both cruciate ligaments and resurfaced the patella. Following standard surgical procedure, the TKA was virtually implanted, thus defining its reference configuration. Each derivative replaced knee model was then obtained by changing the values of one parameter, or a combination of two, in a range based on literature and surgical experience (Table 1).

A 10 s loaded squat to 120° was performed for each configuration, with a constant vertical hip load of 200 N. These settings match the experimental tests performed in a previous in-vitro analysis on cadaver legs. Each replaced model was developed and analyzed using a validated musculoskeletal modeling software.

The model of the knee included TF contacts and PF contacts of the TKA components, passive soft tissues and active muscle elements. The external forces (ground reaction and weights), the muscle forces (quadriceps and hamstrings) and the frictional forces are applied to the knee joint through the machine. The mechanical properties of the tissues were obtained from literature. With these settings, for each model, both the maximum PF and TF contact forces have been evaluated.

Results

Examples of fingerprint graphs are shown presenting the main results (Figures 1 and 2). Figure 1 displays a fixed rotation femoral component and a variable rotation tibial component. FIgure 2 displays a variable rotation patella component.

Discussion and Conclusion

In general a TKA should be implanted without surgical errors to obtain the biomechanical behavior for which a TKA was designed because surgical errors can alter the functionality of a TKA. A fingerprinting tool for TKAs was developed and used to show the sensitivity of PF and TF contact forces in surgical variability.

The graphs show that PF contact forces are altered mostly by errors in positioning of the patellar component, while TF contact forces are mostly affected internal and external femoral component rotation and ligament release.

Figures

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Figure 4 HYPERLINK "http://app.istaonline.org/figures/1680.jpg" \t "_blank"
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Figure 6

6A : 3D planning and execution: #1020 September 22nd, 2011, 8:30-9:35

Virtual 3-Dimensional Planning and Patient Specific Surgical Guides for Osteotomies Around the Knee

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Background

Osteotomies around the knee have been used to correct lower limb mal-alignment for over 50 years. The procedure is technically demanding and carries specific risks of neurovascular injury, incorrect planning and execution, and insufficient fixation. In recent years, with the advent of locking plates, fixation techniques have improved significantly but the correct planning and execution of the operation remains difficult. Despite the availability of CT and MRI 3D imaging, surgical planning is still traditionally performed on 2D plain X-rays [1]. Especially with multi-planar deformities, this technique is prone to error. The aim of this clinical pilot study is to evaluate the feasibility of virtual pre-operative three-dimensional planning and correct execution of osteotomies around the knee with the aid of patient specific surgical guides and locking plates.

Patients and methods

Eight consecutive patients, presenting with significant malalignment of the lower limb were included in the study. Pre-operative CT scans of the affected limb and the normal contra-lateral side were obtained and 3D models of the patient's anatomy were created, using dedicated software (Mimics® 3-matic®, Materialise, Leuven Belgium) [2]. These models were used to evaluate the required surgical correction. The healthy contralateral limb was mirrored and geometrically matched to the distal femur or proximal tibia of the healthy side. A virtual opening wedge correction of the affected bone was used to match the geometry of the healthy contralateral bone. Standard lower limb axes measurements confirmed correction of the alignment [3]. Based on the virtual plan, surgical guides were designed to perform the planar osteotomy and achieve the planned wedge opening and hinge axis orientation (see figure 1) . Apart from guiding the osteotomy, the patient specific surgical guide also guided drilling of the planned screw holes. Post-operative assessment of the correction was obtained through planar X-rays, CT-scan and full leg standing X-ray.

Results

One three-planar, three bi-planar and four single-plane osteotomies were performed. All guides could be used during surgery and served accurate guidance of the osteotomy plane and screwholes. The guides matched the bone very well in all cases without remaining toggle. The maximum deviation between the planned pre-operative wedge angle and the executed post-operative wedge angle was 1° in the coronal, sagittal and horizontal plane. The desired mechanical femorotibial axis on full-leg standing X-rays was achieved in 6 patients. Two patients were undercorrected by 1° and 2° respectively. No significant peri-operative complications occurred.

Conclusion

3D planning and guided correction of multi-planar deformity of femur or tibia is a feasible and accurate novel technique.

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Figures

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Figure 1

Keynote lecture 1 : Patient specific instruments for knee replacement by Andrew Price: #1086 September 21st, 2011, 11:00-11:15

Patient Specific Instruments for Knee Replacement

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No abstract available

14B : Revision and difficult cases - Hip: #647 September 23rd, 2011, 13:50-14:40

Modular Dual Mobility Acetabular Components: An Important Extension of a Proven Approach to Hip Instability

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Introduction:

The published results of the use of a dual mobility cup to prevent instability in primary and revision total hip arthroplasty (THA) have established its efficacy. However, the monoblock, porous cobalt chromium cup design makes secure fixation difficult to achieve, limiting its use in patients with significant acetabular deformity or bone loss. Recently, a modular version of the dual mobility cup was introduced, consisting of a conventional porous shell with holes to allow augmented screw fixation, a highly polished modular metal liner, and a standard bipolar femoral head. The purpose of this report is to present its various indications, the surgical technique, and report our initial results.

Methods:

With IRB approval and FDA clearance, we implanted the modular dual mobility (MDM) cup in 15 patients undergoing primary and 5 patients undergoing revision THA deemed high risk for instability. Indications included septic and aseptic revision surgery, developmental hip dysplasia, avascular necrosis, recurrent dislocations, hemiarthroplasty conversion to THA, periprosthetic fracture, abductor insufficiency requiring augmented repair, and hypermobility from auto-immune inflammatory disease.

Surgical Technique:

The acetabulum is prepared in the standard fashion for implantation of a press-fit component. After implantation and possible screw augmentation, osteophytes are removed. A modular metal liner is manually inserted into the shell by lining up tines and then impacted into place. Concentric positioning must be confirmed. After standard femoral stem preparation, a dual-mobility head with multiple neck length options is easily assembled and placed on the trunion. The hip is then located and assessed for limb length, stability, and offset.

Results:

In the 15 primary THAs, successful implantation of the MDM construct was accomplished without issues related to the aforementioned technique. Adjunct screw fixation was utilized in 8 patients based on initial rim fit and bone quality. In all cases, the hip had to be manually dislocated because of increased stability. There were no peri-operative complications related to the MDM.

In the 5 revision cases, insertion was possible in 4 of 5 patients. In 2 cases, the MDM liner was used in previously implanted, well-fixed and positioned metal acetabular shells compatible with the MDM insert. In 2 cases, the original metal cup was replaced with a shell compatible with the MDM insert. In the remaining patient, a failed hemi-resurfacing, the use of the MDM was abandoned because of impingement and excessive lengthening causing the inner trial head to disassociate from outer trial head.

Discussion:

The MDM cup offers a number of important features not available on the original dual mobility designs. These include the use of: 1) a conventional shell, inserted with familiar instrumentation; 2) a shell that can be used with either a highly cross-linked polyethylene liner or the modular polished metal liner; 3) conventional cancellous screws that makes possible augmented fixation in cases of significant bone loss or acetabular deformity. These features make possible the use of the dual mobility concept without the need to add to a hospital's cup inventory. The initial results in a variety of primary and revision conditions have been encouraging.

6B : Survival / Outcome: #743 September 22nd, 2011, 8:30-9:35

An Analysis of Readmission After Total Hip and Total Knee Arthroplasty

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Introduction:

Readmission after Total Hip Arthroplasty (THA) or Total Knee Arthroplasty (TKA) places a great burden on the health care system. As reimbursement systems place increased emphasis on quality measures such as readmission rates, understanding the causes for readmission becomes increasingly important.

Methods:

We queried an electronic database for all patients who underwent THA or TKA at our institution from 2006 through 2010. We identified those who had been readmitted within 90 days of discharge from the initial admission. We then collected clinical and demographic data as well as readmission diagnoses by ICD-9 code. We compared rates of readmission using chi-squared test.

Results:

6436 patients underwent THA or TKA during the study period. Readmission rates were as follows: unilateral THA, 190 of 2546 (7.5%); bilateral THA, 0 of 13 (0%); unilateral TKA, 288 of 3553 (8.1%); bilateral TKA, 32 of 337 (9.5%), for a combined rate of 7.9%. There was no significant difference in the rate of readmission among procedures: unilateral THA, unilateral TKA and bilateral TKA (p=0.36). There were no significant differences overall by year of procedure (p=0.44). While there was a wide variety of readmission diagnoses, the top three were wound complications (ICD-9 Group 998, 18.5%), procedure-related complications (ICD-9 Group 996, 15.5%), and cellulitis (ICD-9 Group 682, 5%).

Conclusions:

Readmission after THA or TKA occurs with substantial frequency. Postoperative stiffness requiring manipulation (within ICD-9 Group 996) and wound complications (within ICD-9 Group 998) are the most common reasons for readmission. Procedure-related complications and wound complications accounted for more readmissions than medical complications. A clearer understanding of the factors related to these complications, along with accurate diagnosis and coding, should make a reduction in their occurrence possible.

14B : Revision and difficult cases - Hip: #705 September 23rd, 2011, 13:50-14:40

Impaction Bone Grafting: Comparision of Two Impaction Modes

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In Total Hip Arthroplasty (THA) bone loss is recovered by using compacted porous bone chips. The technique requires the morsellised allograft to be adequately compacted to provide initial stability for the prosthesis in order to prevent early massive subsidence and to induce bone remodeling. Therefore the bone grafts provide initial stability and an environment in which revascularization and incorporation of the graft into the host skeleton may

occur. Acetabular reconstruction with impacted morsellised cancellous grafts and cement leads to satisfactory long-term results. In the acetabular impact-grafting procedure, a hammer and an impaction stick is used for manual compaction. Another technique uses a hammer driven by compressed air, which could lead to higher density and improved stability of bone chips in the acetabulum. The aim of this study was to compare two different compaction modes for bone impaction grafting for the acetabulum. The hypothesis was that a pneumatic impaction method would produce less variable results than the manual impaction mode and lead to better compaction results of the bone chips in less time.

Bone mass characteristics were measured by force and distance variation of a penetrating punch, which was lowered into a plastic cup filled with bone chips. For each compaction method and for each time interval (0, 3, 6, 9, 12, 15 and 30 [s] of compaction time) 30 measurements of force and distance variations were taken. From the measurements of force and distance variations bulk density, contact stiffness, impaction hardness and penetration resistance were calculated before and after the established time intervals of compaction. Since not all data was normally distributed the non-parametric U-Test was used for comparison of the two impaction methods. Particle size distribution was determined using sieve analysis according to Din 18123 standard after the compaction experiments.

Results have shown that the pneumatic method leads to higher values in impaction hardness, contact stiffness and bulk density and is more suitable to increase the primary stability of the implant. The differences in bulk density, impaction hardness and contact stiffness where statistically significant ($p<0.01$). No significant differences were found between the two different methods concerning the penetration resistance. The coefficient of uniformity C_u, calculated from the particle size distribution determined by the sieve analysis, has a value of 3.8.

The particle size distribution is comparable to the results published in literature. Pneumatic impaction achieves higher density values in less time with less force applied and results in more reproducible outcomes when used. It reduces therefore the risk of bone fracture, as smaller peak forces are used for less time. However for optimal osteointegration it is not recommended to achieve maximum density. Further clinical studies should determine a reference value for optimal growth-in of osteocytes. Manual impaction shows more variable results and depends much on the experience of the surgeon. The pneumatic hammer is therefore a suitable tool to standardize the impaction process for acetabular bone defects.

1B : MIS - Hip: #1109 September 21st, 2011, 8:30-9:35

The Influence of Material and Instrument Design on Load Transmission in Broach Handles: Comparison of Three Different Designs

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In minimally invasive direct anterior total hip arthroplasty double offset broach handles are used, in order to facilitate the preparation of the femoral canal. The maximum value of the main force peak and the impulse of two types of double offset broach handles (A European version, B American version) were compared to a single offset broach handle (S). Results have demonstrated that the highest values of the main force peak and force impulse were found in the single offset broach handle. Broach handle A had higher impulse values and lower maximum force values compared to broach handle B. In double offset broach handles less energy is transmitted to the tip. Broach handle A has a lower force peak than B and therefore a reduced risk of bone fracture.

9B : Short stems: #689 September 22nd, 2011, 14:55-15:45

Effect of Geometric Variables in a New Cemented Hip Femoral Stem Concept

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Introduction

The orthopaedic market offers more than two hundred different hip femoral stems. Of these, very few have undergone scientific studies with published results. The differences of designs of the stem are mainly related to surface texture and geometry sections. The development of a new cemented hip prosthesis is certainly a very hard task if aiming the improvement of actual performance.

Materials and Methods

This study presents the influence of geometric variables in a novel hip stem concept which was based on the comparison of the performance of the best cemented stems actually in the market. The study was developed using finite element analysis and experiments with in vitro femoral replacements. A numerical simplified model of the hip replacement was designed to generate the final geometry of the femoral stem section. After an in vitro cemented commercial stem was done, with the best cemented stem a Lubinus, Charnley, Stanmore and Müller. Realistic numerical models also allowed us to determine cement mantle stresses of commercial femoral stems that were compared with those obtained for the new concept stem. The new model was then prototyped and tested through in vitro fatigue tests. Finally fatigue tests were also performed to determine the density of cracks in the cement mantles, as well as debonding for both conventional and new designs.

Results

Stem section geometry influences the fatigue mechanism at the stem–cement interface and is an important factor in the load transfer. The organic section presents 60% (average) less cement stress than sharp sections. Concerning the new stem, detail design geometry parameters were analyzed, such as collar position and orientation, medial radius and geometry of the stem tip. The simulations performed show that the new stem design presents 98.5% of cement volume under an equivalent stress lower than 3 MPa [FIG 1]. The correlation factor between this percentage with the clinical follow up results for 10 years of commercial stems is 0.964, being p=0.641 the significance level of one tailed Person correlation.

Discussion

The variables associated to the stem geometry presents influence in the cement mantle stress and could improve the success. The section of stem is an important factor to improve the load transfer. The [FIG.2] presents a resume of some variables in a new concept. The inclination of collar 5º at sagital plane reduces the stress in 10% proximally. The tip geometry influences the stress in cement and improves the femoral position. The tip geometry could reduce 20% of cement stress in distal region.

Conclusions

The new femoral design was based on the findings of the finite element analysis and fatigue tests. It presents an innovative collar, "organic" geometry sections and a geometry tip that minimizes stress concentration. The stem developed reduces the cement stresses in an average of 25% relatively to the commercial stems used in the study. The work demonstrates in a new hip concept that small details in design of cemented hip may have consequences in the implant success.

Figures

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Figure 4

15B : Bearing materials: #497 September 23rd, 2011, 14:50-15:40

Wear Particle Analysis - a Question of the Magnification?

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Johannes S. Rieger - University of Heidelberg - Heidelberg, Germany
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Background:

Polyethylene (PE) as a bearing material for total joint replacements (TJR) represents the golden standard for the past forty years. However, over the past decade it becomes apparent that PE wear and the biological response to wear products are the limiting factor for the longevity of TJRs. For this reason research has focused onto PE wear particle analysis. A particle analysis highly depends on the methodological work and results often show discrepancies between different research groups. From there, our hypothesis was, that an often unattended influencing factor is the optical magnification which has been used for particle analyses.

Material and Methods:

In the present study samples of a previous conducted knee wear simulator test were used. Wear particles were isolated from the bovine serum using an established method[1]. Briefly the serum was digested with hydrochloric acid and a continuous stirring and heating. Particles were filtered onto 20nm alumina filters and analyzed using high resolution field emission gun scanning electron microscopy (FEG-SEM). Filters were analyzed on the same points using three different magnifications: 5000, 15000 and 30000. To describe the size and morphology of the particles the equivalent circle diameter (ECD), aspect ratio (AR), roundness (R) and form factor (FF) were specified according to ASTM F 1877-05. The estimated total number (ETN) of particles was calculated based on the number of particles recovered on the filter, the analyzed area, the dilution, evaporation and the total serum volume.

Results:

The results showed significant differences between the different magnifications. Examples of the analyzed pictures are depicted in Fig.1. The results are summarized in Tab. 1. In particular the size of the particles highly depends on the choosen optical magnification which becomes apparent in a more than twofold increase when comparing wear particles at magnification of 5k or 30k ($p \leq 0.001$). The mean particle diameter distribution (Fig.2) also shows a shift in the distribution of wear particles: A higher magnification results in a higher fraction of smallest particles (e.g. over 50 percent between 0-0.2μm with magnification 30.000 compared to only 3 percent with a magnification of 5.000) and nearly no particles above 1μm could be verified. The results regarding the particle morphology show smaller but significant differences. The ETN of particles quadruplicates when comparing results with magnifications of 5.000 and 30.000.

Conclusion:

This study shows great differences in particle size, which can be directly attributed to the differences in optical magnification. According to ASTM F1877-05 a magnification of 10.000 for the analysis of wear particles between 0.1-1μm is recommended. However, results show that this magnification is not sufficient especially for particle sizes below 0.2μm, which account for the greatest number of particles. To the authors opinion a more detailed recommendation concerning the magnification is needed. Additional, a standardized evaluation system which takes the magnification into account is necessary to allow comparison of different research groups.

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Figures

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Figure 1 HYPERLINK "http://app.istaonline.org/figures/472.jpg" \t "_blank"
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Figure 3

1A : Kinematics and Wear-knee: #516 September 21st, 2011, 8:30-9:35

Influence of Test Frequency and Serum Replacing Interval on Teh Polyethylene Wear Rate in Knee Wear Simulator Tests

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Background:

Polyethylene (PE) wear is known as a limiting factor for total knee replacements (TKR). Thus, preclinical wear testing is an important tool to assess the suitability of new designs and new materials. However, standardized testing (e.g. according to ISO 14243) does not cover the individual situation in the patient. Consequentially, this study investigates the following two parameters:

a) Testing-Frequency: Patients with TKR`s show a humiliated walking frequency (down to 0,5Hz) compared to standardized testing (1Hz±0.1). In the first part of this study, the influence of a decreased test frequency on the PE wear behavior is investigated

b) Interval of lubricant replacement: For in-vitro testing bovine serum is used as a substitute for the synovial fluid. Physiologically a continuous regeneration and removement of destructed components is taking place. In contrast, for simulator testing the bovine serum is typically changed completely every 500.000 cycles/steps. Therefore the goal of the second part of this study was to test if the serum replacing interval affects the PE wear behavior.

Material and Methods:

Wear tests were conducted on an AMTI force controlled knee simulator. A cruciate substituting (ultracongruent) implant design (TC Plus, Smith & Nephew, Rotkreuz, Switzerland) was used.

First, a reference wear study with a test frequency of 1Hz and a lubricant replacement interval (RI) of 500.000 cycles according to ISO 14243-1:2009 was carried out. Tests were run to a total of 5 million cycles.

A second wear test was run with a reduced frequency of 0.5 Hz. The reduced frequency resulted in an extended testing period for the same number of cycles. To exclude an influence of the extended time period, the lubricant was changed, in the first half of testing every 500.000 cycles corresponding to 12 days (cycle depending (CD)), and in the second part every 250.000 cycles corresponding to 6 days (time depending (TD)). Tests were run to a total of 3 million cycles.

A third test was run with a frequency of 1 Hz. For this test a reduced serum RI of 150.000 cycles was choosen. This test was run to a total of 1.500.000 cycles.

Results:

The results of wear testing are given in Fig. 1 & 2. There was no difference for testing at a lower frequency in the case, that the serum replacement occurred at the same time interval ($p=0.234$). However, if the replacement interval is extended or reduced, the wear rate decreases (2.69mg/Mc) or increases respectively (15.87mg/Mc) ($p=0.001; p\leq0.001$). There is a great time depending influence of the serum RI. This influence is shown in Fig.3, comparing the wear rates in dependency to the time period of lubricant change.

Conclusion: This study shows that there is no influence of the reduced testing frequency in a TKR wear simulator study on the PE wear rate. However, there is a massive influence of the lubricant replacement interval. Thus the interval of replacing is of crucial importance for the interpretation of wear simulator studies. The reasons for the changes in the tribological behavior of the bovine serum have to be investigated in further studies.

Figures

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Figure 3

Uncemented Fixation Is All We Need in the 21st Century

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Based on numerous national registries, cemented hip replacements have globally better long-term results than uncemented hip replacements. For example, following data have been published in national registries:

England and Wales – 7th annual report (2010):

Table 3.9

Revision rate at 5 years for cemented implants:	3.0% (2.9% - 3.1%)
Revision rate at 5 years for uncemented implants:	3.7% (3.3% - 4.1%)

Australia – Annual report 2010:

Table HT21

Revisions per 100 observed years for cemented implants:	0.67 (0.57 – 0.69)
Revisions per 100 observed years for uncemented implants:	0.83 (0.80 – 0.86)

Sweden – Annual report 2008:

Page 50

Percent not revised at 17 years for cemented implants:	86.5% (85.8% – 87.1%)
Percent not revised at 17 years for uncemented implants:	67.2% (64.2% – 70.1%)

These registries demonstrated clearly that cemented fixation should be definitively preferred than uncemented fixation… Despite this evidence, uncemented fixation is more and more used in the majority of the countries performing total hip replacements.

A recent paper HYPERLINK "" \l "_edn1" [i] analysed the Swedish situation and may give some reasons for explaining this paradox. A Cox proportional hazards model was used to analyze the Relative Risk (RR) of revision for different type of implants and/or fixation for 170,413 total hip arthroplasties. The RR was adjusted for sex, age, and underlying diagnosis. If the RR is lower than 1, less revisions are seen with uncemented fixation and less revisions are seen with cemented fixation when the RR is higher than 1. The figure 1 summarizes the table 6 of this publication.

This figure naturally confirms that globally cemented fixation has a lower revision burden with an adjusted RR of 1.5 (revision of any component for aseptic loosening) than uncemented fixation. This difference in the revision is controlled by the cups, where the adjusted RR for uncemented cups is 1.8. Stems demonstrate an opposite behaviour with a lower revision burden for uncemented fixation with an adjusted RR of 0.4.

Analysing the revision rate of the 5 most common implants (cemented versus uncemented), the adjusted RR for aseptic loosening is lower than 1 for both cups and stems. The difference of the RR between all cups (RR: 1.8) and the 5 most common cups (RR: 0.5) indicates undeniably that some cup have a major influence on the revision rate of uncemented systems.

This analysis allows to draw following conclusions:

In national registries, cemented fixation is globally superior.

The lower clinical results of uncemented fixation seem to be controlled by badly designed uncemented implants.

Modern uncemented implants have as least equivalent results than cemented implants.

Based on these results, uncemented fixation will be the key fixation for this century.

HYPERLINK "" \l "_ednref1" [i] N.P. Hailer et al; Uncemented and cemented primary total hip arthroplasty in the Swedish Hip Arthroplasty Register – Evaluation of 170,413 operations; Acta Orthopaedica, 81, 2010, p. 34

Figures

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Figure 1

Expandable Prostheses After Resection of Bone Sarcomas of the Femur in Growing Children: Comparative Statistical Analysis of Three Different Prosthetic Systems in the Rizzoli Experience.

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Introduction:

Historically, amputation or rotationplasty were the treatment of choice in skeletally immature patients. The introduction of expandable endoprostheses in the late 1980s offered the advantages of limb-salvage and limb length equality at skeletal maturity and a promising alternative with improved cosmetic results and immediate weight bearing.

Objective:

To describe the Rizzoli experience in reconstruction with three different types of expandable prostheses in growing children with malignant bone tumors of the femur, assess the outcome of limb salvage in these patients, analyze survival and complications related to these prostheses used over time.

Materials and Methods:

Between 1996 and 2010, 39 expandable implants were used in 32 children (16 boys and 16 girls; mean age, 9 years at initial surgery) with bone sarcomas of the femur treated with limb salvage using expandable prostheses. The most common diagnosis was osteoblastic osteosarcoma; all children were classified as having a stage IIB lesion and had preoperative and postoperative chemotherapy. The minimally invasive Kotz Growing prosthesis was used in 17 cases (10 primary implant and 7 revision after failure of non-invasive Repiphysis®), the non-invasive Repiphysis® in 15 cases and Stanmore® expandable prostheses in 7 cases. The mean follow-up was 48 months. Functional evaluation and survival analysis of the children and implants were performed.

Results:

The rate of implant-related complications was 51.3%; 9 prostheses (23%) were revised because of aseptic loosening, infection and breakage. The mean total lengthening was 26 mm (4 to 165 mm) achieved by 78 procedures (2.4 procedures/patient). Three of the nine children who reached skeletal maturity had limb length equality and six discrepancy of 15-30 mm. The survival of the children was 94% and 76% at 24 and 72 months. The survival of the primary prostheses was 90% and 70% at 24 and 72 months. Survival was significantly higher only for the Kotz compared to the Repiphysis® prostheses (p= 0.026). The mean MSTS score was excellent (79%) without a significant difference between the type of prostheses (p= 0.934).

Conclusions:

In the growing children expandable prostheses are viable reconstruction options with good and excellent oncological and functional outcome, and limb-length equality at skeletal maturity. Mechanical failures including aseptic loosening and breakage, dysfunction of the expansion mechanism, contractures especially around the knee, dislocation and infection were the most common; some designs have been associated with an unacceptably high inherent risk of complications. However, the non-invasive systems are associated with high complications and failure rates. Early experience is promising, but further study is warranted to determine long-term structural

integrity of these newer designs.

14A : Patella: #942 September 23rd, 2011, 13:50-14:40

Characterizing Alignment Parameters Affecting Patellofemoral TKR Mechanics

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Complications of the patellofemoral (PF) joint remain a common cause for revision of total knee replacements. PF complications, such as patellar maltracking, subluxation, dislocation and implant failure, have been linked to femoral and patellar component alignment. Computational analyses represent an efficient method for investigating the effects of patellar and femoral component alignment and loading on output measures related to long term clinical success (i.e. kinematics, contact mechanics) and can be utilized to make direct comparisons between common patellar component design types. Prior PF alignment studies have generally involved perturbing a single alignment parameter independently, without accounting for interaction effects between multiple parameters. The objective of the current study was to determine critical alignment parameters, and combinations of parameters, in three patellar component designs, and assess whether the critical parameters were design specific.

A dynamic finite element (FE) model of an implanted PF joint was applied in conjunction with a 100-trial Monte Carlo probabilistic simulation to establish relationships between alignment and loading parameters and PF kinematics, contact mechanics and internal stresses (Figure 1). Seven parameters, including femoral internal-external (I-E) alignment, patellar I-E, flexion-extension (Fâï¿½ï¿½E) and adduction-abduction (A-A) rotational alignment, and patellar medial-lateral (M-L) and superior-inferior (S-I) translational alignment, as well as percentage of the quadriceps load on the vastus medialis obliquus (VMO) tendon, were perturbed in the probabilistic analysis. Ten output parameters, including 6-DOF PF kinematics, peak PF contact pressure, contact area, peak von Mises stress and M-L force due to contact, were evaluated at 80 intervals during a simulated deep knee bend. Three types of patellar component designs were assessed; a dome-compatible patellar component (dome), a medialized dome-compatible patellar component (modified dome), and an anatomic component (anatomic). Model-predicted bounds at 5 and 95% confidence levels were determined for each output parameter throughout the range of femoral flexion (Figure 2). Traditional sensitivity analysis, in addition to a previously described coupled probabilistic and principal component analysis (probabilistic-PCA) approach, were applied to determine the relative importance of alignment and loading parameters to knee mechanics in each of the three designs.

The dome component demonstrated the least amount of variation in contact mechanics and internal stresses, particularly in the 30 - 100° flexion range, with respect to alignment and loading variability. The modified dome had substantially reduced M-L contact force when compared with the dome. The anatomic design, while wide bounds of variability were predicted, had consistently greater contact area and lowered contact pressure than the dome and modified dome designs. The anatomic design also reproduced more natural sagittal plane patellar tilt than the other components. All three designs were most sensitivity to femoral I-E alignment. Thereafter, sensitivity to component alignment was design specific; for the anatomic component, the main alignment parameter was F-E, while for the domed components it was a combination of F-E and translation (M-L and S-I) (Figure 3). Understanding the relationships and design-specific dependencies between alignment parameters can add value to surgical pre-operative planning, and may help focus instrumentation design on those alignment parameters of primary concern.

Figures

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Figure 6
: #941 , 0:00-0:00

Evaluating Knee Replacement Mechanics During Activities of Daily Living With PID-Controlled Finite Element Knee Simulation

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Experimental knee simulators for component evaluation or *in vitro* testing provide valuable insight into the mechanics of the implanted joint. The Kansas knee simulator (KKS) is an electro-hydraulic whole joint knee simulator, with five actuators at the hip, ankle and quadriceps muscle used to simulate a variety of dynamic activities in cadaveric specimens. However, the number and type of experimental tests which can feasibly be performed is limited by the need to make physical component parts, obtain cadaveric specimens and the substantial time required to carry out each test. Computational simulations provide a complementary toolset to experimental testing; experimental data can be used to validate the computational model which can subsequently be used for early evaluation and ranking of component designs. The objective of this study was to explore potential improvements to loading and boundary conditions in current computational/experimental models, specifically the KKS, in order to develop representations of several activities of daily living (ADLs) which reproduce *in vivo* knee joint loading measurements.

An existing finite element model of the KKS was modified to extend the capability, and improve the fidelity, of the computational model beyond the experimental setup. An actuator to allow anterior-posterior (A-P) motion of the hip was included and used to prescribe relative hip-ankle A-P kinematics during the simulations. The quadriceps muscle, which in the experimental simulator consisted of a single quadriceps bundle with a point-to-point line of action, was divided into four heads of the quadriceps with physiological muscle paths. The hamstrings muscle, which was not present in the experiment, was represented by point-to-point actuators in four bundles. A flexible control system was developed which allowed control of the quadriceps and hamstrings actuators to match a knee flexion profile, similar to actuation of the experimental KKS, but also allowed control of the compressive tibiofemoral (TF) joint force, medial-lateral (M-L) load distribution, internal-external (I-E) torque and A-P load at the joint. A series of sensors, measuring all six load components on the medial and lateral compartments of the tibial insert, as well as knee flexion angle, were incorporated into the simulation. Instantaneous measurements from the sensors were fed to a control system, implemented within an Abaqus/Explicit user subroutine (Figure 1). The controller was used to drive actuators in the FE model to match target *in vivo* joint loading profiles, measured from telemetric patient data. The control system was applied to recreate *in vivo* loading conditions at the knee joint during three ADLs for three different subjects (Figure 2), with excellent agreement between simulation joint loading conditions and the target profiles; RMS differences were less than 1°, 80N, 2.5%, and 0.8Nm for knee flexion angle, compressive joint load, M-L load split and I-E torque, respectively, throughout the cycle for all three activities (Figure 3). The flexible nature of the control system ensures that it can be used to evaluate an expansive variety of 'effect of' studies, as well as to determine advanced loading profiles for the experimental simulator.

Figures

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Figure 6
3B : Hip mechanics: #759 September 21st, 2011, 13:50-14:40

Effect of Femoral Offset Alteration on Gait After Total Hip Arthroplasty

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Introduction:

A decrease of 15% in femoral off-set (FO) was reported to generate a weakness of the abductor muscle after THA, which may increase the risk of limping and dislocation. However, this value was defined under experimental conditions using a CYBEX machine, which does not correspond to daily life activities. To our best knowledge, there is no reported study about the effect of the FO alteration on the gait, following THA.

Materials and Methods

To assess the functional consequences of an alteration in the FO, a prospective comparative study was carried out and it included patients who underwent THA for primary osteoarthritis.

In order to select only patients with an isolated FO alteration, the three-dimensional hip anatomy was analysed preoperatively and post-operatively with CT-scans using HipPlan Software. Three groups were defined according to the FO alteration: 15% decrease, restored and 15% increase. The exclusion criteria were: the presence of an arthroplasty or of an associated pathology on the contra-lateral or the same limb, a spine disease and a non-restoration of the other hip parameters (center of rotation, limb length). 26 patients were included: 12 restored, 9 decreased FO and 5 increased FO. The patients were composed of 20 women and 6 men with an average age of 67.7 ± 9 years. All the patients were assessed clinically, pre-operatively and 1 year after surgery with 4 scores: the Poste Merle d'Aubigné score, the Harris score, the womac score and the quality of life score SF12.

A gait analysis was performed at 1 year follow-up using an ambulatory device (Physilog (3)) under normal walking conditions. The patients were asked to walk at their usual normal speed for 30 metres in a standardized corridor: Each limb was compared to the contra-lateral healthy limb.

Results

Contrarily to the restored and the increased groups, there was in the decreased group a significant asymmetry between the operated limb and the healthy side with a decreased knee range of motion (8°, $p<0.004$) and a lower maximal swing speed. (30°/s, $p<0.01$) (Figure). There was no significant difference in the clinical scores between the three groups. However, there was a significant decrease in hip adduction in the decreased FO group

Discussion

The main finding of this study was that an isolated decrease in FO after THA generated an alteration of the gait with a lower swing speed and a decreased knee range of motion when walking. A 15% decrease in FO was proved to induce a gait asymmetry in the sagittal plane. This should be kept in mind for THA planning because X-rays underestimate the FO of up to 20%. This is why; the authors use now routinely CT-scan in order to perform a three-dimensional pre-operative planning for THA.

There was no significant difference between the groups regarding the clinical scores. These scores may be not adapted for an accurate clinical assessment after THA for young and active patients who have highly demanding physical activities.

Figures

Keynote Lecture 13 : Patient-Matched Patellofemoral Arthroplasty by Vineet Sarin: #996 September 23rd, 2011, 13:35-13:50

Patient-Matched Patellofemoral Arthroplasty

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This talk reviews the topic of patellofemoral arthroplasty from a historical, technical, and clinical perspective. Emphasis is placed on the design rationale, surgical technique, and 11 year clinical results of so-called “patient-matched“ or “patient-specific“ patellofemoral arthroplasty in which the trochlear implant is matched to the anatomy of the individual patient through the use of pre-operative computerized imaging scans. The implants are inlayed into the articular cartilage without any intra-operative femoral bone resection. Clinical results involving patient-matched patellofemoral arthroplasty are presented with an average follow-up of 11 years. Case studies reviewing our experience with patient-matched trochlear implants in the setting of femoral trochlear dysplasia are also presented.

Patient-specific patellofemoral arthroplasty is a safe and effective treatment for patients with isolated patellofemoral arthritis. The results compare favorably with off-the-shelf patellofemoral arthroplasties that have been reported on over the past thirty years and can be carried out more efficiently.

We believe the key elements that contribute to the success of patient-matched patellofemoral arthroplasty are as follows: (a) a strict inclusion criteria based on pre-operative radiographic evaluation; (b) a meticulous attention to soft-tissue balance and patellofemoral tracking at the time of arthroplasty; and (c) a patient-specific design and manufacturing methodology that ensures accurate and precise anatomic fit while simultaneously providing proper patellofemoral alignment and medial-lateral constraint.

Fig 1. Patient-specific patellofemoral implant mounted on patient-specific physical bone model, alongside a companion patient-specific drill guide & marking template and all-polyethylene patella button. Collectively these items constitute the patient-specific patellofemoral arthroplasty system described in this talk.

Figures

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Figure 1

9A : Future technologies: #1131 September 22nd, 2011, 14:55-15:45

Cellular Joint Reconstruction

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No abstract available

2B : Patient management: #604 September 21st, 2011, 11:15-12:05

Sugar Therapy for Infection and Skin Ulcer After TKA and BHP.

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Infection and skin ulcer are major problems in Total Knee Arthroplasty (TKA) and Bipolar Hip Prosthesis (BHP). Sugar (sucrose) has been used for wound care in many countries because it absorbs fluid, stimulates granulation, and suppress growth of bacteria. Trafermin （recombinant human basic fibroblast growth factor：bFGF）

accelerates granulation process and improves quality of wound healing. We have used sucrose and trafermin for treatment of infection after TKA and BHP.

Six infected TKA with skin ulcer and one infected BHP with fistula were treated with Trafermin and sugar. TKA were performed in four osteoarthritis and two rheumatoid arthritis, and BHP was for femoral neck fracture.

Implants were removed in three cases because of deep infection. One was male and six were female, average age were 60.8 years old ranged 43 to 77. Follow-up period were one to 5 years. Four cases were related to MRSA. Sugar treatment were performed for two to 23 weeks, and Trafermin was sprayed once a day for two to 16weeks. In BHP case, sugar therapy was performed intermittently.

In two deep infected TKA cases, infection ceased in one to 4 month and revision TKA were performed. In other four TKA cases, infection were ceased in two to 16 weeks. In BHP case, fistula closed in three years.

Combination of Trafermin and sugar is useful for management of infection and skin ulcer after TKA and BHP

9A : Future technologies: #560 September 22nd, 2011, 14:55-15:45

Tribological Performance of Femtosecond Laser-Induced Periodic Surface Structures

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Introduction:

The tribological performance of grooved surfaces has been thoroughly analyzed, and such surfaces are thought to have great potential for hard-on-hard joint prosthesis. In related research, femtosecond laser-induced periodic surface structures (FLIPSSs) have been well developed to achieve grooved structures with submicron spacing (700nm) and amplitude (200nm). In this study, submicron-scale periodic grooved structures were made on SUS440C using a femtosecond laser, and its tribological performance was evaluated by both a pin-on-plate reciprocating sliding test and a ring-on-disk test.

Method:

The pin-on-plate reciprocating test was performed using PAO6 (30.51cP at 37°C) as the lubricant. The pin and plate specimens were made of SUS440C and were polished to a surface roughness of 0.02μm Ra. The pin specimens were columnar in shape, and radial periodic grooved structures (700nm spacing x 200nm amplitude) were formed on the pin's outer periphery (from 4mm to 5mm in diameter).

The ring-on-disk test was performed using lubricants with different viscosity: PAO6 and PAO2 (4.60cP at 37°C). The ring-on-disk specimens were made of SUS440C and were polished to a surface roughness of 0.03μm Ra. Along the surface of the ring specimens, material was removed to create 4 elevated sections at 0°, 90°, 180° and 270°. These 4 sections were then polished and concentric grooved structures (700nm spacing x 200nm amplitude) were created along a 1.4mm circumferential path within each of these areas.

Result:

Fig.1 shows the relationship between sliding speed and friction coefficient for the pin-on-plate test, where the friction coefficient for the periodic grooved specimen was lower than that for the polished specimen under all sliding speed conditions. Fig.2 shows the relationship between resting time and friction coefficient for the pin-on-plate test, where the friction coefficient for the periodic grooved specimen was lower than that for the polished specimen under all resting time conditions. Fig.3 and Fig.4 show the relationship between sliding speed and friction coefficient for the ring-on-disk test using PAO6 and PAO2, respectively. The friction coefficient for the periodic grooved specimen was also lower than that for the polished specimen under all sliding speed conditions regardless of the lubricant. In the case of PAO6, the lubrication mode for the periodic grooved specimen changed from mixed lubrication to fluid lubrication at speeds of 20mm/s or more. However, in the case of PAO2, the friction coefficient for the periodic grooved specimen was relatively high at lower sliding speed conditions.

Discussion:

As human joint movement has a relatively long resting time, relatively low startup-friction performance is essential. Results shown in Fig.1 and Fig.2 suggest that the periodic grooved structure has the potential to improve lubrication and fluid film recovery during startup sliding. Despite results from the ring-on-disk test revealing higher friction coefficients in low-viscosity lubricant at low sliding speeds, grooved specimens still achieved a lower friction coefficient. Due to the fact that joint fluid viscosity changes with shearing speed and protein adsorption on the joint surfaces influences joint friction, we are now preparing a more clinically relevant testing system using bovine serum as a lubricant.

Figures

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Figure 4

11A : Knee kinematics: #867 September 22nd, 2011, 17:40-18:30

A Motion Analysis Framework for Non-Invasive in-Vivo Evaluation of Knee Joint Performance

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Jorg Leffler - St. Marien-Krankenhaus - Siegen, Germany
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INTRODUCTION

In patients with neural disorders such as cerebral palsy, three-dimensional marker-based motion analysis has evolved to become a well standardized procedure with a large impact on the clinical decision-making process. On the other hand, in knee arthroplasty research, motion analysis has been little used as a standard tool for objective evaluation of knee joint function. Furthermore, in the available literature, applied methodologies are diverse, resulting in inconsistent findings [1]. Therefore we developed and evaluated a new motion analysis framework to enable standardized quantitative assessment of knee joint function.

MATERIALS AND METHODS

The proposed framework integrates a custom-defined motion analysis protocol with associated reference database and a standardized post-processing step including statistical analysis. Kinematics are collected using a custom-made marker set defined by merging two existing protocols and combine them with a knee alignment device. Following a standing trial, a star-arc hip motion pattern and a set of knee flexion/extension cycles allowing functional, subject-specific calibration of the underlying kinematic model, marker trajectories are acquired for three trials of a set of twelve motor tasks: walking, walking with crossover turn, walking with sidestep turn, stair ascent, stair descent, stair descent with crossover turn, stair descent with sidestep turn, trunk rotations, chair rise, mild squat, deep squat and lunge. This specific set of motor tasks was selected to cover as much as possible common daily life activities. Furthermore, some of these induce greater motion at the knee joint, thus improving the measurement-to-error ratio. Kinetics are acquired by integrating two forceplates in the walkway. Bilateral muscle activity of 8 major muscles is monitored with a 16 channel wireless electromyography (EMG) system. Finally, custom-built software with an associated graphical user interface was created for automated and flexible analysis of gait lab data, including repeatability analysis, analysis of specific kinematic, kinetic and spatiotemporal parameters and statistical comparisons.

RESULTS

Following ethical approval and informed consent, the proposed framework was successfully applied in a control group of 80 normal subjects within a wide age-range (age: 54.5Y±19.1; BMI: 25.5±4.0; 40M/40F; 60 Caucasian, 20 Asian) thus constructing the reference database for control. Moreover, the same framework was applied successfully in a randomly selected group of 10 patients with a bi-compartmental knee replacement (BKR) (age: 67.3Y±5.3; BMI: 29.7±3.1; time post-op: 1.65Y±0.4; 2M/8F Caucasian). Comparison between these patients and age-matched controls demonstrates that, for a large range of motor tasks, knee joint kinematics after BKR are as much consistent with the healthy controls (coefficient of multiple correlation (CMC) =0.49) as the consistency within a group of controls or BKR-subjects individually (CMC=0.52). Nevertheless, also significant differences

(p<0.0167) were identified which are indicative for retention of pre-operative motion patterns and/or remaining compensations.

CONCLUSION

The proposed framework allows in-vivo evaluation of knee joint performance in a standardized, objective and non-invasive way. It is applicable in both healthy subjects and knee replacement patients and is shown to be sufficiently sensitive to detect even relatively small differences between the two populations.

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: #534 , 0:00-0:00

Maximal Flexion After Total Knee Arthroplasty: A Randomized Controlled Trial Comparing the Journey to the Genesis II Prosthesis

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Introduction.

An important factor in the functional results after total knee arthroplasty (TKA) is the achieved maximal flexion. To date, a TKA still provides dissimilar flexion capabilities compared to the healthy knee, which could be due to the mismatch between the normal knee geometry and the implant geometry. The implant design of the Journey (Smith&Nephew) aims to replicate the normal knee function. According to the manufacturer of the Journey system, it intends to replicate PCL and ACL function, accommodates deep flexion, induces normal tibiofemoral axial rotation and provides proper patellar tracking throughout the entire range of flexion ('guided motion'). The objective of this study is to investigate the maximal knee flexion one year after surgery of the Journey and its predecessor the Genesis II (Smith&Nephew). In addition, clinical and functional outcomes will be evaluated.

Methods.

A total of 124 patients presenting with noninflammatory osteoarthritis received the Journey or the Genesis II prosthesis, by randomization. The primary outcome was defined as the maximum flexion angle on a lateral X-ray performed with the patient lying on a bench and using manual force on bending the knee. Secondary outcomes were: active flexion (lying and standing), Knee Society System score (KSS), Patella Scoring System (PSS), number of adverse events (AE) and satisfaction. The changes in KSS and PSS between the pre-operative situation and 1 year after surgery were calculated as: $\Delta KSS = KSS_{1\ year} - KSS_{pre\text{-}op}$, and $\Delta PSS = PSS_{1\ year} - PSS_{pre\text{-}op}$. Two-sided t-tests and non-parametric alternatives were performed in order to test for differences between the Journey and the Genesis II group.

Results.

The demographic and flexion characteristics were comparable between the two groups at baseline. No significant differences could be observed in maximal flexion on X-ray as well as the active flexion between both groups at 1 year (Figure). Median maximal flexion on X-ray was 127° (range 83°-150°) in the Journey group and 125° (range 81°-145°) in the Genesis II group. The active flexion was lower (p<0.001) than the flexion on X-ray (both lying and standing, median 120°). The ΔKSS and ΔPSS scores improved significantly more for the Genesis II (p=0.018 and p=0.005, respectively). In the Journey group 40 AEs in 27 patients were reported, including 14 manipulations under anaesthesia (MUA), 10 patients with persistent pain, 3 insert exchanges, and 2 total system revisions. In the Genesis group, 13 AEs were observed in 12 patients, including 6 MUAs, 3 patients with persistent pain, and 1 insert exchange. Patients were equally satisfied in both groups.

Discussion.

An increased maximal flexion of the Journey prosthesis could not be shown. In both groups patients did not use the maximum of their flexion ability. Less improvement in clinical and functional outcomes and a higher number of adverse events were observed in the Journey group. The achieved kinematics of this current Journey implant design show an increased lateral roll-back as compared to the native knee which probably causes the functional problems. In conclusion, this new design does not result in the desired increased flexion and better clinical and functional outcome.

Figures

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Figure 1

9B : Short stems: #859 September 22nd, 2011, 14:55-15:45

Femoral Neck Preservation: A Novel Hip Stem. Preliminary Results

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The Parva stem has been designed in order to achieve a good cervical and interthrocanteric primary fixation associated with a reliable fit at the isthmus level.

The stem has been conceived to address the larger possible variety of proximal femoral anatomic variations too.

Ability to adapt to patients anatomies being one of the major limitations of earlier neck preserving implants.

The stem therefore features innovative design concepts including the latest generation Modular Neck System, coupled with a revolutionary metal powder manufacturing process and surface engineering technology.

Our first 150 cases with minimum 1 year follow up are presented. All patients have been followed employing the Harris Hip Score and the reduced WOMAC questionnaire to judge their degree of satisfaction.

Particular care has been posed to analyze results for those patients anatomies (i.e. Very Valgus or Varus femurs) where normally neck sparing stems have problems to correctly fit in.

The feed-back we had with this very innovative implant is very encouraging.

Further data collection and longer follow up will be needed in order to confirm these early promising results.

13B : Hip arthroplasty: #837 September 23rd, 2011, 11:15-12:05

Outcome at Fifteen Years for Cemented Total Hip Arthroplasty in Patients Under 30 Years and the Outcome of Their Revisions

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Introduction

Especially in young patients, total hip implants with proven long-term follow-up data should be used. Despite this, almost all patients under 30 years old will face a revision of their hip prosthesis during their life time because of their life expectancy. Therefore, all the used implants should be revisable with reliable outcome. Although, several studies have evaluated the outcome of different THA implants in patients under 30, only few report the long term follow-up of 10 years or more. None of them present the outcome of the revised total hips.

Methods

We retrospectively reviewed prospectively collected data of 48 consecutive patients (69 hips), all received a cemented implant and in case of acetabular bone stock deficiency (29 hips), a reconstruction with bone impaction grafting (BIG) was performed. Mean age at surgery was 24.6 years (range, 16.0-29.0 years). Two patients were lost to follow-up. As far as we know, no revisions are performed in these two patients and their data are included in the study up to their last radiographic control. All failed hips were revised with again cemented implants and, if needed, bone impaction grafting. For the primary THA Kaplan-Meier survival curves at 10- and 15-year endpoint

revision for any reason and revision for aseptic loosening were calculated. Separate survival rates at 10- and 15-year were calculated for the BIG group versus the non-BIG group. The outcome of the revised hips was studied and reported with re-revision as the endpoint.

Results

Mean follow-up of all 69 hips was 11.5 years (range 2-23.4 years). During follow-up 13 revisions were performed. No stem revisions occurred, except in 3 septic failures. The 10- and 15-year survival rates with endpoint revision for any reason were 86% (95%-CI: 74-92%) and 75% (95%-CI:59-86%), the same endpoints revision for aseptic loosening were 90% (95%-CI: 79-96%) and 82% (95%-CI: 65-92%), respectively. The 10- and 15-year survival rates with endpoint revision for any reason in the BIG group were 93% (95%-CI: 74-98%) and 83% (95%-CI:49-95%), whereas for the non-BIG group the rates were 81% (95%-CI: 69-91%) and 71% (95%-CI:50-84%). None of the 13 revisions needed a re-revision within 10 years after re-implantation, although one cup failed after 13 years.

Conclusion

This study shows that cemented primary total hip implants in patients under 30 years have acceptable outcomes at 10 and 15 years after surgery. Remarkably, the outcomes of the bone impaction grafting technique are superior to non BIG hips, the BIG-group shows a higher survival percentage as the non-BIG group. However, the most interesting part of the study is that the revised hips, all again re-cemented and, if needed, reconstructed with bone impaction grafting were performing well with no re-revisions within 10 years after surgery.

Figures

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Figure 2

Plenary session 3 : The future of TKA: #1075 September 23rd, 2011, 9:45-10:30

Why I Choose for Cement in Young THA Patients

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Summary presentation Wim Schreurs in Symposium The Future of THA on Friday

Background.

Because of the long life expectancy of young total hip arthroplasty (THA) patients and the limited durability of prosthetic implants in young patients, surgeon's always must take into account that the primary THA will be revised in the future. Therefore, not only the survival of the primary total hip in young patients is important, but we would also like to accentuate the revisability of a primary THA in this specific and high demanding patient population.

Methods.

Based on our philosophy, we always use cemented hip in young patients, if needed with acetabular bone impaction grafting. 343 consecutive cemented THA in 270 patients under the age of 50 years were evaluated, all implanted between 1988 and 2006. We also assessed the results of the revised THA (n=53) within the same population. Clinical, radiographical and survival of primary and revision THA were evaluated.

Outcome.

Survival analysis of all 343 hips with endpoint revision for any reason of either component showed a survival of 86% after 10 years. Survival of the stem and cup with endpoint aseptic loosening 93% after 10 years. Remarkably, the THA in which the cemented cup was combined with acetabular bone impaction grafting had a survival of 90% (SE 2.8) in contrast to a survival of 82% (SE 3.4) of the cups without an acetabular revision with endpoint revision for any reason of the whole prostheses(log-rank test, p=0.156) at 10 years. With no patient lost during follow-up, 53 primary hips were revised after a mean follow-up of 8.9 (range 2.0-19.3) years. The average follow-up of the revision THA was 4.2 (range 0.1-14.8) years. Three hips of this revision cohort needed a repeat revision, two had a reinfection after a septic revision and one revised cup failed 12 years after revision. The survival of the revised cohort with endpoint revision for any reason was 91% after 5 years , with endpoint aseptic loosening the survival at 5 years was 100 %. As well after primary as revision THA good clinical outcome

scores were measured.

Interpretation.

Cemented implants in young patients showed satisfying results in primary as well as after revision THA with very acceptable survival and clinical outcomes. Keeping in mind that the young patient will outlive their primary THA, the primary hip has to be revisable and the results of the revision THA must be as good as the primary THA. Bone defects both in primary and revision THA can be successful managed with impacted bone grafts, without the need for augments, cages or larger implants.

Keynote Lecture 2 : Local Antibiotics in Orthopedic Use by Peter Seidel: #1071 September 21st, 2011, 11:00-11:15

Local Antibiotics in Orthopedic Use

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Local antibiotics in orthopedic use

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INTRODUCTION

Surgical site infections (SSI) in orthopaedics are a major source of postoperative morbidity. Although perioperative antibiotic prophylaxis is a common practice, orthopaedic infections are still high in numbers, due to the increasing use of osteosynthesis material and implants. Implants are avascular and can be easily colonized with biofilm-producing germs. For both, effective prophylaxis and treatment of orthopaedic infections, the right choice of the antibiotics used, the mode of application (only systemic or systemic & local), the timing, dosage and the duration of antibiotics are of extremely high importance. Their inappropriate use does not only lead to failures in prevention or treatment of infections, but may also promote microbial resistance development and may cause serious side effects for the patients.

SELECTION & USE OF ANTIBIOTICS

Prophylaxis: Broad-spectrum prophylactic antibiotics should help to eliminate the germs before they start to colonize the implant. For prophylactic purposes the recently published AAOS guidelines [1] recommend the use of cephalosporins, such as cefazolin or cefuroxim, administered within one hour prior to surgery. In cases of suspected beta-lactam allergy, clindamycin or vancomycin can be used. The latter one is also recommended in cases of MRSA colonisation. Due to extended infusion times, vancomycin should be started within two hours prior to incision. In cases of blood loss or long op duration, antibiotic administration must be repeated (e.g. cefazolin, every 2-5 hrs; vancomycin, every 6-12 hrs). There is no evidence of a benefit of continued antibiotic administration past 24 hrs of end of surgery [2]

Treatment: In cases of established infections, use of antibiotics is only considered as an adjuvant to surgical debridement. Typically, the choice of the appropriate antibiotic depends on the bacteria, its antibiotic sensitivity profile and the health state of the patient. A combination of rifampicin & a quinolone (or rifampicin & vancomycin in cases of MRSA) for at least 2 wks up to several months has shown good results [3]. In chronic infections with biofilm involvement, all foreign material must be removed and locally delivered antibiotics via e.g. PMMA as carrier (spacers, PMMA-chains) are of additional clinical benefit.

ROLE OF LOCAL ANTIBIOTICS

There is general consensus that PMMA chains or PMMA spacers loaded with specific antibiotics support the

eradication of bone and joint infections, because of the high local concentrations achieved. The exact treatment time is, however, variable, ranging from few weeks up to several months. Only small amounts of these local antibiotics are systemically detectable and do not represent a major risk for side effects. Still a matter of debate is the benefit of antibiotic impregnated PMMA for infection prophylaxis. Although common practice in Europe, its routine use in e.g. primary arthroplasty is still discussed in other world regions. Meanwhile, evidence accumulates that joint infection rates are, indeed, lower, if antibiotic loaded bone cement with high initial release rates is routinely used in arthroplasty[4].

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6A : 3D planning and execution: #1033 September 22nd, 2011, 8:30-9:35

Change in Algorithm for Correction of Moderate (Gr.2) FFDs in TKR

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Introduction:

Fixed Flexion deformity (FFD) is a common deformity amongst patients due to undergo TKR. For their correction surgical algorithm is documented. Resection of distal femur and clearing off posterior recess are two essential steps. In balancing these knees it is suggested to resect extra distal Femur to gain extension space.

Aim:

To demonstrate full FFD correction without resecting extra distal Femur.

Methods:

In this prospective study during the yr. 2009-2010 32 cases were recruited. All the cases were performed by the author and a PS design of the implants were used.

Inclusion Criteria: All cases of Gr2 deformities. (OA or Inflammatory arthropathy.)

Exclusion Criteria: Patients with h/o previous injury, fractures, surgery (ies).

Surgical Technique:

Distal Femur is resected as per distal thickness of the implant to be inserted (9 to 11mm). Standard Tibial cut & Femoral AP cut are made using the mechanical jigs. Thus flexion and extension spaces are created. If extension space is tight at this stage, Posterior release is done. Posterior osteophytes are resected and capsule is reflected off the posterior Femur. If FFD still persists then temptation to resect extra distal femur is avoided.

A further more aggressive posterior release is performed. In stepwise manner following structures are addressed. Posterior ledge of the femoral condyles is resected with a curved osteotome. Capsule is reflected further proximally and if need be then resected horizontally at the level of the Tibial resection. Thus extension space is equalized to the flexion space. (Video clipping)

Results:

Out of 32 Knees 24 were OA and 8 Inflammatory arthropathy. 27 pt.s were females and 5 were males. Mean age at operation 64.5 years (52.1 to 82.7 yrs) Pre op KSS score was 51 (28 to68). Mean post op KSS 90 (72 to 96).

All but 2 pt.s had full correction of FFD intra op and remained corrected at mean average follow up of 1yr. The patients maintained a night splint for 1 month. They were encouraged to perform static and dynamic quadriceps

exercise from day 1.

2 patients had residual 5 degree FFD at the end of the operation. Of this 1 patient was neutral at 1 yr. follow up. One continued to have 5 degrees FFD.

Discussion:

FFDs correction requires a careful planning of surgical steps. In following Gap balancing technique, to achieve extension space sometimes there can be erroneous Distal Femoral resection. We have demonstrated here that by addressing posterior structures more aggressively we can achieve extension space equal to flexion space. There are certain advantages of not resecting extra distal Femur namely…

1) No elevation of Joint line and hence preventing Midflexion laxity

2) Mismatch of components size of femur and Tibia is prevented

3) In very small knees (Asian patients) damage to collateral ligament insertion is prevented.

Conclusion:

In this study all the patients had full correction. There are clear advantages of not resecting extra distal Femur. We continue to use this technique for Gr.2 FFDs. We suggest change in the current algorithm for correction by not removing extra distal femur.

15B : Bearing materials: #564 September 23rd, 2011, 14:50-15:40

Wear Simulation of a Fluoroscopic-Derived Activity of Daily Living

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INTRODUCTION:

Knee simulators are being used to evaluate wear. The current international standards have been developed from clinical investigations of the normal knee [1, 2] or from a single TKA patient [3, 4]. However, the forces and motions in a TKA patient differ from a normal knee and, furthermore, the resulting kinematic outcomes after TKA will depend on the design of the device [5]. Consequently, these standard tests may not recreate in-vivo conditions; therefore, the goal of this study was to perform a novel wear simulation using design-specific inputs that have been derived from fluoroscopic images of a deep knee bend.

METHODS:

A wear simulation was developed using fluoroscopic data from a pool of eighteen TKA patients performing a deep knee bend. All patients had a Sigma CR Fixed Bearing implant (DePuy) and were well functioning (Knee Society Score > 90). A single patient was selected that represented the typical motions, which was characterized by early rollback followed by anterior motion with an overall modest internal tibial rotation (Figure 1). The relative motion between the femoral and tibial components was transformed to match the coordinate system of an AMTI knee wear simulator [6] and a compressive load input was derived using inverse dynamics [7]. The resulting force and motions (Figure 2) were then applied in a wear simulation with 5 MRad crosslinked and remelted polyethylene for 3 Mcyc at 1 Hz. Components were carefully positioned and each joint (n=3) was tested in 25% bovine calf serum (Hyclone Laboratories), which was recirculated at 37±2°C [3]. Serum was supplemented with sodium azide and EDTA. Wear was quantified gravimetrically every 0.5 Mcyc using a digital balance (XP250, Mettler-Toledo) with load soak compensation.

RESULTS:

The knee simulator was able to recreate the in-vivo input kinematics. The femoral low point location revealed good agreement between in-vivo and in-vitro conditions and the overall pattern of the motion from full extension to maximum knee flexion was replicated (Figure 3). The measured wear from these inputs was very low (0.7 ± 0.2 mg/Mcyc).

DISCUSSION:

We have performed a device-specific wear simulation for a deep knee bend. Surprisingly, the wear associated with this activity was very low. It is possible that abnormal kinematics, including paradoxical anterior slide and reverse rotation, would generate higher wear. The deviations the between in-vivo and in-vitro kinematics (Figure 3) are likely due to a size mismatch across the transformation process. In a previous study [7] we recreated the in-vivo motions with better fidelity (RMS error = 0.6mm) using size matched components. Further work is needed to improve the transformation technique for different sized components. Also, similar approaches will be used in future investigations to study the effect of abnormal kinematics as well as other designs including rotating platform and cruciate substituting devices.

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Figures

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Figure 1 HYPERLINK "http://app.istaonline.org/figures/592.jpg" \t "_blank"
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Figure 3

5A : Knee mechanics: #831 September 21st, 2011, 16:20-17:10

Variation of Femoro-Tibial Contact Forces With Knee Flexion

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INTRODUCTION

Telemetric implants have provided us with invaluable data as to the in vivo forces occurring in implanted knee joints. However, only a few of them exist. The knee is one of the most studied joints in the human body and various mathematical knee models have been used in the past to predict forces. However, these simulation studies have also been carried out on a small group of patients limiting their general usefulness in understanding overall trends of knee behavior. Therefore, it is the purpose of this research to study the implant forces experienced by a large group of patients so as to have a better understanding of the overall magnitudes and their variability with knee flexion.

METHODS

The patients were selected from a large database of over 3000 knees for which kinematic analysis had previously been carried out using fluoroscopy. The criteria used for selection was that the patients had a successful knee implant (HSS >90) and were able to perform a weight bearing deep knee bend of at least 110 degrees. The patients

were randomly chosen without any other restrictions. The kinetic analysis was carried on a cohort of over 100 patients using a previously published inverse dynamic rigid body model. This model, which has been validated using telemetric data, is capable of predicting the contact forces on the medial and lateral condyles of the knee. Analysis was carried out till 130 degrees of flexion to remove any effect of thigh calf contact that the model does not incorporate. 20 normal knees were also included for comparison.

RESULTS

The contact force variation through the weight bearing flexion cycle can be divided into 3 distinct regions: (1) 0 degrees to 90 degrees the contact forces generally increase, (2) 90 to 120 degrees the forces reach a peak (3) beyond 120 degrees the forces decrease (Figure 1). Though similar at full extension, the contact forces in the implanted patients were found to be significantly higher than the normal knee subjects with increase in flexion. The maximum force for any implanted patient was found to be around 4.5BW while for the normal knee it was around 3.3BW. For the implanted knees the medio-lateral force distribution was close to 50-50 at full extension and increased slightly with the increase in flexion. For the normal knees however, the increase in flexion was found to increase the load on the medial side considerably (Figure 2).

DISCUSSION

From a design perspective, it is good to note that the contact forces reduce at higher flexion angles. This is probably due to the wrapping of the quadriceps tendon on the femur causing the moment arm of the quadriceps to increase as the contact points move posterior with flexion. Compared to the normal knee, contact positions in implants tend to stay more anterior which causes higher contact forces. Ligament release, performed during knee implant surgery, tends to equal out the medio-lateral force distribution as compared to the normal knees.

Figures

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Figure 4

12B : Hip arthroplasty: #1011 September 23rd, 2011, 8:30-9:35

Midterm Results of Uncemented Acetabular Reconstruction for Post-Traumatic Arthritis Secondary to Acetabular Fracture

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[Background and Objective]

Total hip arthroplasty (THA) has been applied to treat pain and disability in patients with post-traumatic arthritis after acetabular fracture for many years. However, the midterm and long-term results of THA for this unique population are still controversial. According to previous studies, we found that uncemented acetabular reconstructions were usually performed in patients who were most likely to have the best results and an abnormal acetabular structure was usually the reason for THA failure. In this study, we evaluated the midterm results of using uncement acetabular components to treat posttraumatic arthritis after acetabular fracture. In addition, we investigated the effects of different acetabular fracture treatments and fracture patterns on THA.

[Materials and Methods]

Between January 2000 to December 2003, 34 uncemented acetabular reconstructions were performed in 34 patients for posttraumatic arthritis after acetabular fractures. Among them, 31 patients underwent complete clinical and radiographic follow-up for an average of 6.3 years (range, 3.1–8.4 years). There were 22 men and 9 women. The patients' average age was 51 ± 12 years (range, 27–74 years) at the time of arthroplasty. The average interval from fracture to THA was 5.58 ± 4.42 years (range, 0.75–17.5 years). Of the 31 patients, 19 had undergone ORIF (open-reduction group) and 12 had received conservative treatment for the acetabular fractures (conservative-treatment group). Then, 14 had simple pattern fractures (simple group) and 17 had complex pattern fractures (complex group). After midterm follow-up, the radiographic and clinic results of the different groups

were compared.

[Results]

During 6.3 years' follow up, no infection occurred and no revision was needed in the 31 patients. In the open-reduction and conservative-treatment groups, the respective averages for duration of surgery, intraoperative blood loss, and amount of blood transfused were 138 ± 29 minutes and 98 ± 16 minutes (P < .001), 726 ± 288 mL and 525 ± 101 mL (P = .01), and 1,130 ± 437 mL and 1,016 ± 422 mL (P = .62). In the complex group and the simple group, the respective averages for duration of surgery, intraoperative blood loss, and amount of blood transfused were 132 ± 28 minutes and 109 ± 31 minutes (P = .042), 741 ± 221 mL and 536 ± 248 mL (P = .02), and 1,100 ± 414 mL and 1,075 ± 456 mL (P = .91). The average Harris Hip Score increased from 49 ± 15 before surgery to 89 ± 5 in the latest follow up, and 29 patients (94%) had either excellent or good results. The average Harris Hip Score for the open-reduction group and the conservative-treatment group increased to 87 ± 6 and 91 ± 3 (P = .07), respectively, after surgery; for the complex group and the simple group, it increased to 88 ± 6 and 90 ± 4 (P = .25), respectively. There was no significant difference between the open-reduction group and the conservative-treatment group or between the complex group and the simple group regarding the number of hips with excellent and good results. Of our 31 patients, none had a change in acetabular component abduction of >4°. The average horizontal migration of cup was 1.48 ± 0.46 mm (range, 0.7–2.33 mm), and the average vertical migration was 1.41 ± 0.54 mm (range, 0.5–2.51 mm). The average rate of polyethylene liner wear was 0.25 ± 0.11 mm/y (range, 0.03–0.41 mm/y). Average wear rates were 0.25 ± 0.12 mm/y and 0.24 ± 0.11 mm/y for the open-reduction group and the conservative-treatment group (P = .72), respectively, and 0.24 ± 0.13 mm/y and 0.26 ± 0.10 mm/y in the complex group and the simple group (P = .67), respectively. The average rate of polyethylene wear for all patients was positively related to BMI (r = .36; P = .047). After THA, all 31 patients had a reconstructed hip center within 20 mm of vertical and horizontal symmetry compared with the contralateral hip, including 27 patients (87%) with anatomic restoration and 4 patients with reconstructed hip center between 10-20 mm of vertical and horizontal symmetry. Anatomic restoration was positively related to fracture treatment (r = .48; P = .006), but it had no relation to fracture pattern (r = .16; P = .40).

[Conclusion]

Uncement acetabular reconstruction following acetabular fracture had favorable midterm results. Fracture treatments and patterns are associated with increased operative time and hemorrhage amount. Open reduction and internal fixation of fracture favours anatomic restoration of hip rotational center.

2B : Patient management: #610 September 21st, 2011, 11:15-12:05

Post-Operative Morbidity Associated With Total and Unicompartmental Knee Arthroplasty: A Multi-Center Analysis

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Introduction:

This study compares the incidence of post-operative complications (within 90 days) following primary total knee arthroplasty (TKA) and unicompartmental knee arthroplasty (UKA).

Methods:

2,919 Consecutive patients were retrospectively reviewed over 5 years at three institutions; 2,290 underwent primary TKA and 629 underwent UKA. Simultaneous bilateral procedures and diagnoses other than osteoarthritis were excluded. Regression analysis was performed to isolate the effects of TKA versus UKA on the rate of post-operative complications.

Results:

Patients undergoing TKA had a longer length of hospital stay (mean 3.3 vs. 2.0 days, p<0.0001) and were less likely to be discharged to home (odds ratio 5.2, p<0.0001). TKA was associated with a higher risk of undergoing a manipulation (odds ratio 13.0, p<0.0001), requiring a transfusion (odds ratio 8.5, p=0.036), being admitted to an ICU (odds ratio 7.4, p=0.049), and a higher risk of overall complication (11% vs. 4.3%; odds ratio 2.8, p<0.0001) compared to UKA. With the numbers available for this study, there was a trend towards a higher risk of deep infection (0.8% vs. 0.2%; p=0.13) and re-operation for any reason within 90 days (1.4% vs. 0.6%;p=0.064). The

risk of complications was higher for TKA even when patients were stratified by Charlson comorbidity index (p=0.008).

Conclusion:

The increased risk of peri-operative complications, the longer length of hospitalization and the higher risk of requiring discharge to an extended care facility following TKA should be considered when counseling patients on the choice of TKA versus UKA.

11A : Knee kinematics: #752 September 22nd, 2011, 17:40-18:30

In Vivo Kinematics of a Posterior Stabilized Total Knee Arthroplasty

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Background:

Various postoperative evaluations using fluoroscopy have reported in vivo knee flexion kinematics under weight bearing conditions. This method has been used to investigate which design features are more important for restoring normal knee function. The objective of this study is to evaluate the kinematics of a Posterior-Stabilized TKA in weight bearing deep knee flexion using 2D/3D registration technique.

Patients and methods:

We investigated the in vivo knee kinematics of 9 knees (9 patients) implanted with a Posterior Stabilized TKA (Triathlon PS, Stlyker Orthopedics, Mahwah, NJ). Under fluoroscopic surveillance, each patient did a deep knee flexion under weight-bearing condition. Femorotibial motion including tibial polyethylene insert were analyzed using 2D/3D registration technique, which uses computer-assisted design (CAD) models to reproduce the spatial position of the femoral, tibial components from single-view fluoroscopic images. We evaluated the knee flexion angle, femoral axial rotation, antero-posterior translation of contact points, and post-cam engagement were evaluated.

Results:

The mean maximum flexion angle was 121.0±9.5°. The amount of femoral axial rotation was 7.5±1.5°. The femorotibial contact point moved posterior 4.9±4.5mm on medial compartment, 10.0±3.3mm on lateral compartment with knee flexion. The mean knee flexion angle at initial post-cam engagement was 47.5±17.2°. The kinematic pattern was medial pivot.

Discussion:

The contact point constantly moved backward especially on the lateral side. At early flexion, both the medial and lateral contact point moved posteriorly, which might be caused by a change in sagittal radius at 10° flexion. The post-cam engagement occurred at midflexion, that might prevent the paradoxical anterior translation of the femur with respect to tibia during knee flexion.

10B : Bearings - hip: #425 September 22nd, 2011, 16:40-17:30

Use of Slide Presentation Software as a Tool to Measure Hip Arthroplasty Wear

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Use of Slide Presentation Software as a Tool to Measure Hip Arthroplasty Wear

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Abstract

Each *in vivo* wear measurement method for total hip arthroplasty (THA) has strengths and weaknesses. The authors have developed a new manual wear measurement method (PowerPoint [PP] method) and validated that the PP method was found to have better repeatability, reproducibility and pick up differences in the radiographs than the previously established manual wear measurement methods. The primary aim of this study was to evaluate the reliability of the PP method by retrieval study. 17 retrieved polyethylene (PE) liners (16 patients) were enrolled in this study. The wear volumes of retrieved PE liners from clinical radiographs were calculated by the PP and Dorr and Wan method and they were compared with the wear volume of retrieved PE liners calculated by the triangulation three-dimensional (3D) laser scan. Spearman correlation coefficients results between PP method and 3D laser scan revealed excellent correlations (0.89 to 0.93). The Intraclass Correlation Coefficients values of the PP method showed excellent correlations (0.95 to 1.00). We suggest that the PP method will be a viable new technique for measuring wear of THA and a supplement method when computerized methods are not available.

12B : Hip arthroplasty: #730 September 23rd, 2011, 8:30-9:35

Polished Tapered Stem in Patients 35 Years or Younger - 12 to 20 Year Results in Patients With a High Risk Profile for Aseptic Loosening

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We report the outcome at a minimum of 10 years follow-up for 80 polished tapered stems performed in 53 patients less than 35-years-old with a high risk profile for aseptic loosening. Forty-six prosthesis were inserted for inflammatory hip arthritis and 34 for avascular necrosis. The mean age at surgery was 28 years in the inflammatory arthritis (17-35) and 27 years in the avascular necrosis (15-35) patients. At a mean follow-up of 14.5 years in the inflammatory arthritis group and 14 years in the avascular necrosis group respectively, survivorship of the 80 stems with revision of the femoral component for any reason as an endpoint was 100 % (95 % CI). Re-operation was because of failure of four metal-backed cups, 3 all polyethylene cups and one cementless cup. None of the stems were radiographically loose. All but two femoral components subsided within the cement mantle to a mean of 1.2 mm (0 tot 2.5) at final follow-up. Periarticular osteolysis was noted in 4 femurs in zone 7. This finding was associated with polyethylene wear and was only seen in those hips that needed revision for a metal backed cup loosening. Our findings show that the polished tapered stem has excellent medium-term results when implanted in young patients with high risk factors for aseptic loosening.

13B : Hip arthroplasty: #1138 September 23rd, 2011, 11:15-12:05

Total Hip Arthroplasty in Inflammatory Arthritis in Young Patients

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No abstract available

10B : Bearings - hip: #929 September 22nd, 2011, 16:40-17:30

ECiMa; the Future of Hip Bearing Technology

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INTRODUCTION

Wear induced osteolysis, material property degradation and oxidation remain a concern in cobalt chrome on polyethylene THR. ECIMA is a cold-irradiated, mechanically annealed, vitamin E blended HXLPE developed to maintain mechanical properties, minimise wear and improve long-term oxidation resistance. This study aimed to compare the *in-vitro* wear rate and mechanical properties of three different acetabular liners; UHMWPE, HXLPE and ECIMA.

METHODS

Twelve liners (Corin, UK) underwent a 3 million cycle (mc) hip simulation. Three UHMWPE (GUR1050, Ø32 mm, γ sterilised), three HXLPE (GUR1020, Ø40 mm, 75 kGy γ, EtO sterilised) and six ECIMA (0.1 wt% vitamin E GUR1020, Ø40 mm, 120 kGy γ, mechanically annealed, EtO sterilised) liners articulated against CoCrMo femoral heads (Corin, UK). Wear testing was performed in accordance with ISO 14242 parts 1 and 2, in calf serum, with a maximum force of 3.0 kN and at a frequency of 1 Hz. Volumetric wear rate was determined gravimetrically.

ASTM D638 type V specimens were machined from ECIMA material for uniaxial tension testing. Ultimate tensile strength (UTS), yield strength and elongation values were measured. These values were compared to mechanical data available for the other material types.

Following completion of the ECIMA wear testing, three of the tested liners were cut in half. One half of each was subject to accelerated ageing in accordance with ASTM F2003-02, while the other half was tested as received. Each liner half was cross-sectioned and a microtome was used to section 200μm thick slices from each cross-section. Oxidation analysis was performed using a Fourier Transform Infra-red technique in accordance with ASTM F2102-01 throughout the thickness of each liner half. Average oxidation indices for each sample were determined.

RESULTS

The reduction in wear rate for the ECIMA liners compared to the UHMWPE and HXLPE liners was 95 % and a 83 % respectively. There was an increase in UTS, yield strength and percent elongation of 45%, 16% and 32% respectively, for unaged ECIMA compared to HXLPE. Following ageing of the ECIMA samples, there was minimal change in all three mechanical properties. Importantly, the mechanical properties were not substantially degraded and were more comparable to conventional UHMWPE than HXLPE. Further to this, following an aggressive ageing protocol, the ECIMA material maintains the mechanical properties of the unaged condition.

All of the oxidation values for the wear tested ECIMA liners, before and after ageing, and the aged, untested ECIMA samples were negative, which shows oxidation levels below the level of detection throughout the thickness of the samples. This indicates a high level of through-thickness oxidation resistance for the ECIMA specimens even after being subject to an aggressive ageing protocol and cyclic loading.

DISCUSSION

These *in-vitro* wear results indicate that ECIMA is a very low wearing material with the potential to reduce wear related osteolysis *in-vivo*. Importantly, the mechanical properties were generally maintained unlike the degradation found in many modified polyethylene materials and were more comparable to UHMWPE than HXLPE. These properties make ECIMA a promising next generation bearing material.

9B : Short stems: #1032 September 22nd, 2011, 14:55-15:45

Bone Remodelling Following THR; Shorts Stems Are Less Likely to Lead to Bone Resorption.

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INTRODUCTION

Bone resorption around hip stems, in particular periprosthetic bone loss, is a common observation post-operatively. A number of factors influence the amount of bone loss over time and the mechanical environment following total hip replacement (THR) is important; conventional long stem prostheses have been shown to transfer loads distally, resulting in bone loss of the proximal femur. More conservative, short stems have been

recently introduced to attempt to better replicate the physiological load distribution in the femur. The aim of this study was to evaluate the bone mineral density (BMD) change over time, in a femur implanted with either a short or a long stem.

METHODS

Finite element models of two implants, a short (Minihip, Corin, UK) and long (Metafix, Corin, UK) hip stem were used to simulate bone remodeling under a physiological load condition (stair climbing). The magnitudes and directions of the muscle forces and joint reaction force were obtained from Heller et al (2001, 2005). An unimplanted femur was also simulated.

A strain-adaptive remodelling theory (Scannel & Prendergast 2009) was utilised to simulate remodelling in the bone after virtual implantation. COMSOL Multiphysics software was used for the analysis. The strain component of the remodelling stimulus was strain energy density per unit mass. This was calculated in the continuum model from the strain energy density, and apparent density.

Bone mass was adapted using a site-specific approach in an attempt to return the local remodelling stimulus to the equilibrium stimulus level (calculated from the unimplanted femur). The minimal inhibitory signal proposed by Frost (1964), was included in the model and described by a 'lazy zone', where no bone remodelling occurred.

The three dimensional geometry of the femur was constructed from computed tomography data of the donor (female, 44 years old, right side). Elemental bone properties were assigned from the Hounsfield Unit values of the CT scans. The elastic modulus of the bone was assumed to be isotropic and was determined using a relationship to the apparent bone density (Frost 1964, Rho 1995). The Poisson's ratio for the bone regions varied between 0.2 and 0.32 depending on the apparent density of the bone (Stulpner 1997).

The period of implantation analysed was 2 years. The muscle forces and joint contact loads applied were ramped linearly from zero to full load over a period of two weeks, representing the estimated post operative rest period of a patient.

RESULTS AND DISCUSSION

The overall percentage BMD change observed for Gruen zones 1 through to 7, were -14%, +4%, +40%, +12%, +4%, 0%, 12% respectively at 2 years for the Minihip. The corresponding overall percentage BMD change observed for Gruen zones 1 through to 7 for the Metafix were -8%, -2%, 18%, 26%, +12%, -9%, -42% respectively (Figure 1,2).

CONCLUSIONS

Considerably more bone resorption occurs in Gruen zone 7 with the long stem. Long stem designs distrupt the mechanical environment more than short stems, and lead to a greater bone mineral reduction over time.

5B : Spine: #707 September 21st, 2011, 16:20-17:10

Bone Graft Viability: A Comparison of PEEK and Trabecular Metal Implants for Cervical Spinal Fusion in a Goat Model

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Background:

Synthetic interbody spinal fusion devices are used to restore and maintain disc height and ensure proper vertebral alignment. These devices are often filled with autograft bone to facilitate bone bridging through the device while providing mechanical stability. Nonporous polyetheretherketone (PEEK) devices are widely used clinically for such procedures.[1] *Trabecular Metal* devices are an alternative, fabricated from porous tantalum. It was hypothesized that the porous *Trabecular Metal* device would better maintain autograft viability through the center of the device, the 'graft hole' (GH).

Methods:

Twenty-five goats underwent anterior cervical discectomy and fusion using a *Trabecular Metal* or PEEK device for 6, 12 or 26 weeks. The GH of each device was filled with autograft bone morsels harvested from the animal at implantation. Fluorochrome labeling oxytetracycline was administered to the animals and used to determine bone viability in the device regions. Following necropsy, the vertebral segments were embedded in poly(methyl methacrylate) sectioned and analyzed using fluorescence and backscatter electron (BSE) imaging. The percent of bone tissue present within the GH was measured as a volume percent using BSE images (Fig. 1).

Results:

Bone percent analysis demonstrated that there was no significant difference ($p<0.05$) in volume of bone tissue within the GH of the two devices at 6 and 26 weeks (Fig. 2). At 12 weeks the animals implanted with the *Trabecular Metal* device had significantly greater volumes of bone within the GH region. Viable bone was observed in the host bone region and periprosthetic to the implant of all PEEK (n=12) and *Trabecular Metal* (n=12) animals within the study, determined by the presence of fluorescent labels (Fig. 3). Viable bone was also observed in the GH region of all animals with a *Trabecular Metal* device. However, only 5 of 12 PEEK animals showed bone viability within the GH (2 at 12 weeks and 3 at 26 weeks). A Fisher's exact comparison of the number of animals with viable bone in the GH showed a significant difference between the two devices, $p<0.05$.

Conclusion:

Autograft viability was better maintained within the GH for the porous *Trabecular Metal* device compared to the PEEK device. Although the amount of bone tissue within the GH of the PEEK devices was determined to have no significant difference compared to the *Trabecular Metal* devices at 6 and 26 weeks, the GH bone tissue was not viable in a number of the PEEK animals at each time point. The interconnected network and high volume porosity of the *Trabecular Metal* device may have allowed for fluid exchange, angiogenesis and increased blood supply to the autograft morsels. The viability of the autograft morsels also played an important role in the success of bone bridging through the GH between the vertebral endplates. In this animal model it was demonstrated that the autograft bone placed within the PEEK spinal fusion device did not always remain viable after implantation, but sometimes only filled the GH and did not necessarily facilitate fusion between the vertebrae as intended.

1.Hee, HT, *et al.,* Spine J 2010; 10:50-57

Figures

14A : Patella: #681 September 23rd, 2011, 13:50-14:40

Gender and Patellar Prosthesis Design Are Risk Factors for Over-Stuffing or Over-Resection of the Patella in TKA.

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Introduction:

Opponents of patellar resurfacing during Total Knee Arthroplasty (TKA) note unique complications associated with resurfacing. Problems include over-stuffing (the creation of a composite patellar-prosthesis thickness greater than the native patella) that may contribute to reduced range of motion; and creation of a patellar remnant that is too thin (in order to avoid over-stuffing) that may contribute to post-operative fracture. Factors including surgical technique, prosthesis design and patient anatomy may contribute to these problems. This study was performed to define the native patellar anatomy, and to compare the effect of differences in component thickness between manufacturers.

Methods:

This retrospective, IRB approved study reviewed 803 knees that underwent primary TKA between 2005 and 2011 with a single surgeon. Patellar resurfacing was performed with a round, polyethylene component from one of two different implant designs using the same surgical technique. Data recorded for each patient included: gender; patellar thickness before and after resurfacing; the dimensions and manufacturer of the prosthesis. The residual patellar bone thickness after resection was calculated.

Results:

Mean (SD) native patellar thickness was 25.24mm (2.11) in males, versus 22.13mm (1.89) in females (P = <0.001). 47/313 (15%) of males had increases in the composite patellar thickness after resurfacing, versus 120/480 (25%) of females (P < 0.001). 123/480 (26%) of females had a residual patella thickness <= 13mm, versus 12/313 (4%) of males (P <0.001). Finally, 79/265 (30%) of patients with a patellar prosthesis from manufacturer B had increases in the composite thickness, versus 88/522 (17%) of patients with manufacturer A (P < 0.001).

Conclusions:

Both patient gender (due to smaller native patellae in females) and prosthesis design (thicker components from manufacturer B) are risk factors for over-stuffing of the patella or over-resection of the patella. These findings suggest that patellar component design can be improved for female patients.

10B : Bearings - hip: #925 September 22nd, 2011, 16:40-17:30

Cross Shear Wear Considerations for UHMWPE Hip Bearings Effect of Sliding Path

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Pin-on-disk studies have demonstrated the role that cross-shear plays in polyethylene wear. It has been found that applying shear stresses on the polyethylene surface in multiple directions will increase wear rates significantly compared to linear sliding. Hip and knee joint replacements utilize polyethylene as a bearing surface and are subjected to cross-shear motions to various degrees. This is the mechanism that produces wear particles in hip and knee arthroplasty bearings and if excessive may lead to osteolysis, implant loosening, and failure. The amount of cross-shear is dependent on the bearing diameter and the angular motion exerted onto the bearing due to the gait of the patient. This study will determine the effect of sliding curvature (angular change per linear sliding distance) on the wear rate of polyethylene. Virgin polyethylene blocks were machined with a 28mm diameter bearing surface and against 28mm cobalt chromium femoral heads in a hip simulator. Dynamic loading was applied simulating walking gait but the motion differed between testing groups. Typical walking gait testing utilizes 23° biaxial rocking motion, in this study, 10°, 15°, 20°, and 23° biaxial rocking motions resulting in various sliding curvatures. Sliding motion path is described in Figure 1 and is a function of the bearing radius and the rocking angle. With increased rocking angle, the sliding distance reduces per cycle and the sliding path becomes more curved (more angular change per linear distance of sliding). Despite a significant increase in sliding distance at higher rocking angles, wear rates were relatively unchanged and ranged from 57mm3/mc to 62mm3/mc. Wear rates per millimeter increased exponentially with reduced sliding arc radius (smaller rocking angle) as shown in Figure 2. This study suggests that wear of polyethylene is highly dependent on sliding path curvature. The sliding path is largely a function of the bearing diameter and the patient activity. Large bearing diameter implants have been recently introduced to increase joint stability. Sliding distance increases proportional to the bearing radius which has led to some concerns regarding increased wear in larger bearings. However, in vitro wear studies have not shown this trend. Increased bearing diameter also increases the sliding path curvature which this study has shown to cause a reduction in wear roughly proportional to the radius of the bearing. Therefore, the increase in wear due to sliding distance is offset by the reduction in wear caused by the sliding curvature resulting in no significant change in wear with increased bearing diameter. Curved sliding path causes a change in surface shear direction which has been shown to increase wear of polyethylene. This study confirms that increased cross-shear in the form of more angular change per linear sliding distance can increase wear of polyethylene exponentially

Figures

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Figure 4
: #1093 , 0:00-0:00

Surgical Navication or Patient Specific Cutting Blocks?

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No abstract available

6A : 3D planning and execution: #1132 September 22nd, 2011, 8:30-9:35

Computer Navigation as a Teaching Instrument in Knee Reconstruction Surgery

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No abstract available

2B : Patient management: #1089 September 21st, 2011, 11:15-12:05

Infection Management - Surgical Management of the Infected Joint: State of the Art

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Microorganisms adhere to foreign bodies and form a biofilm, that protects against natural defence mechanisms and antibiotics. Because of these properties, surgery is required to cure an infected implant.

The type of surgery is different in early, delayed and late hematogenous infections.

Thorough debridement, with retention of the prosthesis but with exchange of the mobile parts, is possible in cases of early infections and in late hematogenous infections, if the implant is stable and the soft tissues intact.

If these conditions are not met and in delayed infections, the implant will have to be removed and a new prosthesis implanted.

This can be done in a one stage or in a two stage procedures; in most centres, one or the other procedure is favoured for all cases.

However, depending of the condition of the soft tissues, the presence or absence of concommittant diseases and the type of microorganism responsible for the infection, a decision toward either a one stage or a two stage procedure can be made.

Salvage procedures like a permanent resection, an arthrodesis or an amputation are less satisfactory for the patient.

7B : Shoulder: #698 September 22nd, 2011, 11:15-12:05

Novel Strategy for Rotator Cuff Deficient Arthritis - Rotator Cuff

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In recently, reverse shoulder arthroplasty for rotator cuff deficient arthritis is widely used in the world. However, a high complication rate was reported and worried about long-term results after reverse shoulder arthroplasty. From2001, we performed a novel strategy for these cases such as rotator cuff reconstruction w/ or w/o muscle transfer and a humeral head replacement with using smallest head to decrease joint volume. The aim of this study was to investigate with clinical outcomes after this surgery more than two years follow-up.

Materials & methods:

Fifty six shoulders underwent humeral head replacement (HHR) with or without tendon transfer for cuff tear arthropathy was able to follow-up more than two years. The mean age was 74 years (60 to 83 years). 42 cuff tear arthropathy, 6 RA, 5 re-tear after cuff repair with arthritis, and 1 arthritis after infection were included. Coracoacromial arch preserved Superior approach with preserving coracoacromial arch was used for replacement

the humeral stem and head. Almost of the cases could be repaired with using a smallest head because of the height of humeral head and joint volume were decreased. However, when rotator cuff remained in irreparable condition, a latissimus dorsi tendon or a pectoralis major tendon from same shoulder was transferred for cuff reconstruction. The patients were divided by 2 groups; 36 shoulders of HHR without tendon transfer and 20 shoulders of HHR with tendon transfer. Each patient was evaluated with Japan Orthopaedic Association score (JOA score) and modified Neer's limited goals rating scale after a least 2 year of follow-up.

Results:

In all cases, preoperative severe pain was dramatically improved. JOA score improve from 40.2 preoperatively to 80.2 postoperatively. Twelve shoulders estimated as excellent in modified Neer's classification, 34 in satisfactory and 10 in unsatisfactory. Half of cases with RA were unsatisfactory results.Postoperative active flexion statistically improved compared to preoperative range of motion. Averaged postoperative flexion was 136 degrees (preop.;68.8) and postoperative external rotation was 28.6 degrees (preop.;13.2). However, there was no significant difference of external rotation in the HHR group between pre and postoperative evaluation. The radiographic evaluation showed four cases of glenoid erosion. One case had arthroscopic Suprascapular nerve release eight years after surgery.

Conclusions:

The current results were consistent with the prior studies. Our novel strategy is considered as one of useful procedure for cuff tear arthropathy. However, the case which classified with Seebauer type IIB should not be recommended.

8A : Knee arthroplasty: #814 September 22nd, 2011, 13:55-14:45

The Influence of Intra-Operative Soft Tissue Balance on Post-Operative Knee Extension in PS-TKA

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Objective

Although both accurate component placement and adequate soft tissue balance have been recognized as essential surgical principle in total knee arthroplasty (TKA), the influence of intra-operative soft tissue balance on the post-operative clinical results has not been well investigated. In the present study, newly developed TKA tensor was used to evaluate soft tissue balance quantitatively. We analyzed the influence of soft tissue balance on the post-operative knee extension after posterior-stabilized (PS) TKA.

Materials and Methods

Fifty varus type osteoarthritic knees implanted with PS-TKAs were subjected to this study. All TKAs were performed using measured resection technique with anterior reference method. The thickness of resected bone fragments was measured.

Following each bony resection and soft tissue releases, we measured soft tissue balance at extension and flexion of the knee using a newly developed offset type tensor. This tensor device enabled quantitative soft tissue balance measurement with femoral trial component in place and patello-femoral (PF) joint repaired (component gap evaluation) in addition to the conventional measurement between osteotomized surfaces (osteotomy gap evaluation). Soft tissue balance was evaluated by the center gap (mm) and ligament balance (°; positive in varus) applying joint distraction forces at 40 lbs (178 N).

Active knee extension in spine position was measured by lateral X-ray at 4 weeks post-operatively. The effect of each parameter (soft tissue balance evaluations, thickness of polyethylene insert and resected bone) on the post-operative knee extension was evaluated using simple linear regression analysis. $P<0.05$ was considered statistically significant.

Results

The thickness of resected bone, flexion center gap and ligament balance at extension and flexion had no correlations to the knee extension angle. Thickness of polyethylene insert correlated positively to knee extension (r=0.38, p=0.007). Significant positive correlation were found between extension center gap in both osteotomy and component gap evaluation to the post-operative knee extension. The coefficient of correlations were 0.33 (p=. 02) with osteotomy gap and 0.47 (p=0.0007) with component gap evaluation.

Discussion and Conclusion

In the present study, extension center gap was found to positively correlate to the early post-operative knee extension. The extension center gap could be considered as the summation of the simultaneous gap from bone resections and the elongation of soft tissue envelope under joint distraction force applied by tensor. The soft tissue with the lower stiffness would be elongated more, and result in the larger center gap. Accordingly, the stiffness of the soft tissue envelope might play an important role on the magnitude of extension center gap and the post-operative knee extension.

Furthermore, the center gap in component gap evaluation had higher coefficient of correlation comparing to that in osteotomy gap. Proposed component gap evaluation in soft tissue balance measurement might be more physiological and relevant to the joint condition after TKA, and useful to predict post-operative clinical results.

15A : Alternative treatments: #517 September 23rd, 2011, 14:50-15:40

Effects of Low-Intensity Pulsed Ultrasound Stimulation on Chondrocytes Cultured on RGD-Induced Fibroin Substrate

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INTRODUCTION

Several reports suggest that low-intensity pulsed ultrasound stimulation (LIPUS) facilitates chondrogenesis[1)]. Recently it has been suggested that LIPUS may be transmitted via Integrin: a protein which mediates cellular attachment between cells and extracellular matrix[2)]. In this study, the Arg-Gly-Asp (RGD) amino acid sequence, which is a ligand of Integrin, was induced to the fibroin substrates by either gene transfer or physical mixing, and the variation of chndrocyte response to LIPUS was evaluated.

EXPERIMENTAL METHODS

Three kinds of culture dishes coated with three diffrent fibroin aqueous solutions were prepared: 1 wild-type, 2 transgenic and 3 mixed. The wild-type aqueous solution was prepared from *Bombyx mori* silkworm cocoons. The transgenic aqueous solution was prepared from *Bombyx mori* silkworm cocoons in which RGD was interfused in the fibroin light chain[3)]. The mixed aqueous solution was prepared simply by blending RGD peptides with the wild-type fibroin aqueous solution. Chondrocytes were asepically harvested from the joints of 4-week-old Japanese white rabbits and then subcultured on T-flasks and seeded at 2.0×10^5 cells/dish. LIPUS stimulation, with spatial and temporal average intensity of 30 mW/cm^2 and a frequency of 1.71 MHz with a 200 ms tone burst repeated at 1.0 kHz, was applied to the chondrocytes at 12, 36, 60 hours and administered for 20 minutes each time. GAG production and the number of chondrocytes were measured by the Dimethylmethylene blue (DMMB) method[4)] and the LDH method[5)], respectively. Extracted mRNA from the chondrocytes was analyzed by using the Syber Green method, where the primers were designed for glyceraldehyde-3-phosphate dehydrogenase (GAPDH) as the house-keeping gene, aggrecan and Sox 9. This data was analyzed using the two-sided Student's t-test.

RESULTS and DISCUSSION

In the transgenic group, the number of chondrocytes and GAG production were increased by the LIPUS stimulation in 1 day of culture (Fig.1,2), and the mRNA expression levels of agrrecan (Fig.3) and Sox 9 were

increased in 2 days of culture. However the mRNA expression level of aggrecan was decreased after 3 days of culture. These LIPUS-derived changes were not found in the wild-type and mixed groups. We previously reported that the adhesive force between chondrocytes and RGD transgenic fibroin surfaces was higher than that for mixed fibroin, suggesting that adhesive force is translated via RGD which bonds covalently to the fibroin proteins for the transgenic group. The present results suggest that the early biological adhesion via RGD on the transgenic fibroin is sensitive to LIPUS.

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Figures

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Figure 1 HYPERLINK "http://app.istaonline.org/figures/516.jpg" \t "_blank"
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Figure 3

Accuracy and Reliability of Three-Dimensional Templating of Cementless Total Hip Arthroplasty for Hip Dysplasia

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Introduction:

Preoperative planning is an essential procedure for successful total hip arthroplasty. Many studies reported lower accuracy of two-dimensional analogue or digital templating for developmentally dysplastic hips (DDH). There have been few studies regarding the utility of three-dimensional (3D) templating for DDH. The aim of the present study is to assess the accuracy and reliability of 3D templating of cementless THA for hip dysplasia.

Methods:

We used 86 sets of 3D-CT data of 84 patients who underwent consecutive cementless THA using an anatomical stem and a rim-enlarged cup. There were six men and 78 women with the mean age of 58 years. The diagnosis was developmental dysplasia in 70 hips and osteonecrosis in 14 hips and primary osteoarthritis in 2 hips. There were 53 hips in Crowe group I, 11 hips in Crowe group II and 6 hips in Crowe group III. Each operator performed 3D templating prior surgery using a planning workstation of CT-based navigation system. Planned-versus-achieved accuracy was evaluated. The templating results were categorized as either exact size or +/- 1 size of implanted size. To assess the intra- and inter-planner reliabilities, 3D templating was performed by two authors blinded to surgery twice at an interval of one month. Kappa values were calculated. The accuracy and the intra- and inter-planner reliabilities were compared between the DDH group (70 hips) and the non DDH group (16 hips).

Results:

There was no significant difference in accuracy of component sizes between the DDH group and the non-DDH group. The accuracy of templating for cup sizes was 76 % for DDH and 75 % for non-DDH group (p=0.95). If

accuracy was expanded to include all cups within one size of the implanted size, the accuracy was 97 % and 94 %, respectively (p=0.51). The accuracy of templating for stem sizes was 60 % for the DDH group and 75 % for the non-DDH group (p=0.27). The accuracy within 1 size was 99 % and 94 %, respectively (p=0.25). Regarding intra-planner reliability, mean kappa value for the cup size was 0.67 in the DDH group and 0.81 for the non-DDH group (p=0.18). Mean kappa value for the stem size was 0.64 in the DDH group and 0.79 for the non-DDH group (p=0.18). There were no significant differences in intra-planner reliability between the DDH and non-DDH group. Regarding inter-planner reliability for the cup size, mean kappa value was 0.33 in the DDH group and 0.37 in the non-DDH group (p=0.14). Mean kappa value for the stem size was 0.46 in the DDH group and 0.69 in the non-DDH group (p=0.07). There were no significant differences in inter-planner reliability between the DDH and non-DDH group.

Conclusion:

The 3D templating for cementless THA was accurate for hip dysplasia. Intra- and inter-planner reliabilities of the 3D templating were comparable with those of other primary diagnosis, while intra-planner reliability of cup sizes was fair regardless of diagnosis.

3B : Hip mechanics: #766 September 21st, 2011, 13:50-14:40

Reliability of Intra-Operative Assessment of Soft Tissue Tension in Total Hip Arthroplasty

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Introduction:

The shuck test was widely used to assess the overall soft-tissue tension around the hip joint during surgery. There have been few attempts to standardize how one evaluates soft tissue tension in total hip arthroplasty. The aim of this study was to ask how reliable the shuck test was as a measure of soft tissue tension in total hip arthroplasty.

Methods:

First, we assessed the intra- and inter-examiner variability of the force generated in the shuck test. Next, we asked how the strength of traction forces and joint position on the distance of displacement of the prosthetic head at surgery. Twenty-one hip surgeons, consisting of seven experienced hip surgeons, seven junior hip surgeons, and seven surgeons in training were included in the first study. Test subjects were instructed to pull a traction gauge with their customary range of force. Each subject performed two sets of the shuck test in one week interval. Eighteen patients who had cementless THA through postero-lateral approach using 3D-CT based navigation system were enrolled in the second study. After implantation of components, the leg was pull caudally using our original device [Fig.1]. The strength of applied traction force was 20 %, 30 %, 40 % and 50 % of body weight of each patient. The distance of displacement of a prosthetic head during traction was recorded at flexion angles of 0, 15, 30 and 45 degrees using the navigation system. Internal or external rotation of legs was controlled within 5 degrees.

Results:

There was a significant difference among examiners in the range of force generated in shuck test. The mean force was 24.1 kg (SD; 6.4, range; 11 to 35). There was no significant difference in the range of force among experienced, junior surgeons and surgeons in training (p=0.11). Intra-class correlation between the tests and re-tests was 0.8. The distance of displacement of prosthetic heads during traction increased with traction forces significantly (p=0.001). There were significant differences in the distance of displacement of prosthetic heads during traction among flexion angles (p=0.001). The femoral head displaced most at the flexion angle of 15 degrees.

Conclusion:

There were considerable inter-examiner differences in the range of forces generated by the shuck test. The strength of traction forces and flexion angles influenced significantly the distance of displacement of prosthetic heads. It is necessary to standardize the strength of traction forces and flexion angles in order to make the shuck test reliable.

Figures

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Figure 2

1B : MIS - Hip: #544 September 21st, 2011, 8:30-9:35

Does Surgical Approach Influence the Position of Acetabular and Femoral Component in Total Hip Arthroplasty? -Comparison Between Direct Anterior and Lateral Approach-

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Background

Between 1999 and August 2005, we performed Direct Lateral Approach (DLA) in lateral decubitus position as the main approach for primary total hip arthroplasty (THA). After August 2005, we introduced Direct Anterior Approach(DAA) in supine position. Intraoperative target orientation in primary THA was planned in 40-45°cup abduction, 10-20°cup anteversion, and 10-20° stem anteversion. Precice implant positioning has been considered to be very important for postoperative function and stability. The purpose of this study was to compare the DLA and DAA for implant positioning accuracy.

Methods

From 1999 to July 2009, we performed 566 primary THAs(78 male,488 female). The subjects were divided into two groups of 224 DLA and 342 DAA (72 in early stage and 270 in late stage) The difference of the mean age at surgery and preoperative diagnosis among the groups were not significant. We planned to set the cup anteversion at 20°in DAA early stage and 12.5°in late stage DAA due to the development of postoperative dislocation in several cases with early stage DAA.We measured the cup and stem alignment postoperatively using radiography and computed tomography, and measured the combined anteversion angle by Widmer .Statistical analysis was done using the Bartlett Statistical Test and F-test. The results were expressed as median and interquartile range, with an alpha level set at less than 0.05.

Results

Cup abduction angle with DLA was 42.7±6.25 °(average±standard deviation) , 42.1±4.1°with early stage DAA and 41.9±5.3°with late stage DAA. There was no significant difference between the approaches with average and standard deviation (SD) of cup abduction. The mean cup anteversion with DLA (17.3±10.0°) was significantly smaller than that with early stage DAA(26.6±8.1°) and late stage DAA(21.0±8.0°). SD of cup anteversion with DLA was significantly larger than that with both DAA groups.The mean stem anteversion was significantly smaller with DLA (18.9±14.3) and late stage DAA (16.7±11.1°) than that with early stage DAA (23.5±11.9°) . SD of stem anteversion with DLA was significantly larger than that with both DAA groups.There were 9 hips of dislocation: 5 hips in DLA, 3 in early DAA and one in late DAA. SD of combined anteversion Value with DLA(30.5±13.7) was significantly larger than that with early DAA (40.3±12.2) and late DAA (32.7±11.1.ï¼ï¿½

Conclusion

Significantly less SD for anteversion of stem and cup was demonstrated with DAA compared with DLA. Stable operative positioning with DAA could yield a more accurate and reliable implantation compared with DLA in lateral position. DAA in supine position was a superior approach for primary THA .

1B : MIS - Hip: #531 September 21st, 2011, 8:30-9:35

Learning Curve of Total Hip Arthroplasty Using the Direct Anterior Approach

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Background:

Minimally invasive surgery is being widely used in the field of total hip arthroplasty (THA). The advantages of the direct anterior approach (DAA), which is used in minimally invasive surgery, include low dislocation rate, quick recovery with less pain, and accuracy of prosthesis placement. However, minimally invasive surgery can

result in more complications related to the learning curve. The aim of this study was to evaluate the learning curve of DAA-THA performed by a senior resident.

Methods:

Thirty-three consecutive patients (33 hips) who underwent primary THA were enrolled in this study. All operations were performed by a senior resident using DAA in the supine position without the traction table. The surgeon started using DAA exclusively for all cases of primary THA after being trained in this approach for 6 months. Operative time, intraoperative blood loss, complications, and accuracy of prosthesis placement were investigated.

Results:

The mean intraoperative blood loss was 524 mL (range, 130-1650 m L). The mean operative time was 60 min (range, 41-80 min). Radiographic analysis showed an average acetabular anteversion angle of 17.0±3.3°, abduction angle of 37.8±4.3°, and stem alignment of 0±0.8°. Thirty-two (97%) of 33 cups were placed within the Lewinnek's safe zone. The overall complication rate was 12% (4 of 33 hips), including 1 proximal femoral fracture (salvaged with circumferential wiring) , 1 temporary femoral nerve palsy (completely recovered in 2 weeks), 1 stem subsidence (5 mm), and 1 cup migration. Three of these complications were occurred in the first 10 cases. No revision surgery was required, No postoperative dislocation occurred.

Conclusion:

We investigated the learning curve of DAA-THA performed by a senior resident. We considered the first 10 cases as the learning curve, but concluded that with adequate training this procedure can be performed safely and effectively without increasing the risk of complications.

5B : Spine: #1043 September 21st, 2011, 16:20-17:10

Comparison of Wear for Polycrystalline Diamond, Cobalt Chrome, and Polyethylene in a High Hertzian Stress Environment

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Purpose:

Total disc replacement (TDR) devices have been restricted to designs with large, congruent articulations due to the limited wear properties of available materials. TDRs with more natural motion could be designed if materials were available which could resist the higher wear conditions. A novel TriLobe TDR design is self-centering and energetically stable, emulating the natural motion of the intact motion segment, but is not feasible using traditional materials due to small incongruent articulating surfaces. The objective of this study was to compare the wear properties of a medical grade polycrystalline diamond with wear properties of cobalt chrome (CoCr) and ultrahigh molecular weight polyethylene (UHMWPE) in aggressive high wear conditions.

Methods:

A modified pin-on-disc, crossing-path wear test was used to measure the wear rates of PCD-on-PCD, CoCr-on-CoCr, and CoCr-on-UHMWPE. The discs were placed in the inferior position on an oscillating plate, moving in a 10mm by 5mm figure-eight pattern. Pins had an initial 11.5mm radius and were loaded at 133N normal to the disc. In a typical pin-on-disc test, a wear flat develops on the pin and the wear rate is reduced as the contact area increases. The TriLobe design uses three lobes sliding in three non-conforming lenses which prevents wear flats from developing. To approximate this condition, the fixture holding the disc was placed on an air bearing and was allowed to rock in concert with movement of the load. The test was conducted in 25% bovine serum at a speed of less than two Hertz. Two sets of each material were tested, one set to 2.0 million cycles and the other set to 14.0 million cycles. Wear rates on the rocking-discs were measured using a high resolution coordinate measuring machine because the wear in the PCD specimens was not detectable gravimetrically.

Results:

The diamond specimen averaged 0.0036mm^3/MC of wear over the first 2 million cycles. The CoCr-on-CoCr

specimens averaged 1.4mm^3/MC and the CoCr-on-UHMWPE averaged 4.7mm^3/MC over 2 million cycles. The PCD specimen taken to 14 million cycles had and average wear of 0.0022mm^3/MC compared to 2.4mm^3/MC and 9.5mm^3/MC for CoCr-on-CoCr and CoCr-on-UHMWPE respectively.

Conclusions:

Using the pin-on-rocking-disc test to approximate small, non-congruent articulating surface wear, both CoCr-on-CoCr and CoCr-on-UHMWPE wore at rates that were orders of magnitude greater than medical grade PCD. At two million cycles, CoCr-on-CoCr had worn nearly 400 times more than PCD and CoCr-on-UHMWPE wore more than 1300 times greater. During the last 12 million cycles the wear in non-diamond specimen accelerated, while the diamond wear rate decreased. At the end of 14 million cycles CoCr on itself and on UHMWPE specimens had worn at more than 1100 times and nearly 4300 times greater than PCD, respectively. Coupled with the inherent biocompatibility, high strength and toughness, and ultra low friction of diamond, the performance of PCD makes it an attractive material for TDR applications. PCD could be used in current designs to alleviate concern over wear debris and ion release and to increase the space for the next generation of TDR devices.

Figures

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Figure 1

Performance of Cervical TDRs for Both Center of Balance and Center of Rotation in a Cadaveric Model

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Purpose:

Few Cervical Total Disc Replacement (TDR) devices are engineered to address both the Center of Balance (COB) and the Center of Rotation (COR) of the cervical motion segments. The COB is the axis in the intervertebral disc through which the axial compressive load is transmitted. TDRs placed posterior of this point tend to fall into kyphosis while devices placed anterior of this point tend to fall into lordosis. Thus from a “balancing” point of view the ideal placement would be at the COB. However, the COR position has been shown to be posterior and inferior to the disc space. It has also been shown that constrained devices tend to lose motion when there is a mismatch between device and anatomic centers. Mobile core devices may be placed at the COB since their unconstrained rotations and translations allow for the device COR to follow the anatomic COR, but they rely heavily on the facet joints and other anatomic features to resist the paradoxiacal motion.

The TriLobe cervical TDR (Figure 2) was engineered for both the COB and COR. The purpose of this study was to compare the 3D kinematic and biomechanical performance of the TriLobe to a ball and trough(BT) cervical TDR in an augmented pure moment cadaveric study to find the ideal AP implant placement.

Materials and methods:

Specimen were CT imaged for three-dimensional reconstruction. Visual, CT, and DEXA screening was utilized to verify that specimens are free from any defects. Specimens were prepared by resecting all nonligamentous soft tissue leaving the facet joint capsules and spinal ligaments intact. C2 and T1 were potted to facilitate mounting in the testing apparatus (7-axis Spine Tester, Univ. of Utah, Salt Lake City, UT). OptoTRAK motion tracking flags were attached to each vertebra including C2/C3 and T1 to track the 3D motion of each vertebra.

- Specimens C2-T1.
- Treatment Level C5-C6.
- Insertion of fixture pins under fluoro.
- Load Control Testing to 2.5Nm in FE, LB, AR at 0.5Hz.
- 15 Pre-cycles in load control in FE / LB / AR (2.5Nm).

• Test implants in load control in FE / LB / AR to 2.5Nm for 4 cycles with data recorded for all cycles.

Results:

[Results Table - Figure 1]

Discussion:

This study showed that the TriLobe had better control of motion compared to the ball and trough both in ROM and varibility for FE, LB, and AR. The TriLobe had better control of limiting kyphosis over the ball and trough by 41% of the flexion motion. The neutral zone slope, an measure for device stability, showed that the TriLobe was 51% more stable than the BT. AP placement of devices showed there was a general trend of decreasing stability from anterior to posterior placement; however, statistical significance was not established.

Figures

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Figure 1 HYPERLINK "http://app.istaonline.org/figures/1430.jpg" \t "_blank" INCLUDEPICTURE \d "http://app.istaonline.org/figures/1430.jpg" * MERGEFORMATINET
Figure 2

3A : Navigation: #566 September 21st, 2011, 13:50-14:40

A New Technology in the Implant Positioning for Total Knee Replacement: Comparison Between Two Custom-Fit Techniques

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Computer-assisted techniques in total knee replacement (TKR) have been introduced to improve bone cuts execution and relevant prosthesis components positioning. Although these have resulted in good surgical outcomes when compared to the conventional TKR technique, the surgical time increase and the use of additional invasive devices remain still critical. In order to cope with these issues, a new technology in TKR has been introduced also for positioning prosthetic components according to the natural lower-limb alignment. This technique is based on custom-fit cutting block derived from patient-specific lower-limb scan acquisition. The purpose of this study is to assess the accuracy of the custom-fit technology by means of a knee surgical navigation system, here used only as measurement system, and post-operative radiographic evaluations. Particularly, the performances of two different custom-fit cutting blocks realized from as many scan acquisitions have been here reported.

Thirty patients affected by primary knee osteoarthritis were enrolled in this study. Fifteen patients were implanted with GMK® (Medacta-International, Castel San Pietro, CH) and as many patients with Journey® (Smith&Nephew, London, UK). Both TKR designs were implanted by using custom-fit blocks for bone cut executions provided by the same TKR manufacturers according to a pre-operative web planning approved by the surgeon. Particularly, the cutting block for the former design was built from CT scan acquisition of the hip, knee and ankle, whereas that for the latter design from MRI scans acquisition of the knee and X-ray lower-limb overview. A knee surgical navigation system (Stryker®-Leibinger, Freiburg, Germany) was used for recording intra-operative alignment of bone cuts as performed by means of the custom-fit cutting blocks and relevant component positioning. Prosthetic components alignments were also assessed post-operatively on X-ray images according to a shape-matching technique. The accuracy of the custom-fit blocks was evaluated through the comparison between pre-operative planning, and intra/post-operative data. Discrepancies above 3° and millimeters were considered as outliers.

Within the patient cohort, nine cases were fully analyzed at the moment and here reported. Over them and except for one case, the discrepancy between pre-operative planned femoral/tibial resection level on the frontal plane and the corresponding measured intra-operatively was within 3 mm, being 5 mm in the worse case. Two outliers were

observed for the corresponding femoral/tibial cut rotational alignment. Particularly, in one patient, the discrepancy in femoral cut alignment was of 8° in flexion and 6° in external rotation; in another patient this was of 4° in extension and 4° in external rotation in the femoral and tibial cut alignment, respectively. Post-operative radiographs evaluations for the final prosthetic components revealed that femoral/tibial alignment were within 3° in all cases, except for those patients that were already outliers.

These preliminary results reveal the efficacy of the custom-fit cutting block for TKR. These were generally fitted properly and final prosthetic components were accurately placed, although some discrepancies were observed. This new technology seems to be a valid alternative to conventional and computer-assisted techniques. More consistent conclusions can be deduced after final evaluation of all patients.

11B : Implant fixation: #838 September 22nd, 2011, 17:40-18:30

New Osseointegrated Fixation Implant for Amputation-Prosthesis Designed to Reduce Bone Failure Risk and Periprosthetic Bone Loss - Finite Element Study.

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For amputated patients, direct attachment of upper leg prosthesis to the skeletal system by a percutaneous implant is an alternative solution to the traditional socket fixation. Currently available implants, the OPRA system (Integrum AB, Göteborg, Sweden) and the ISP Endo/Exo prosthesis (ESKA Implants AG, Lübeck, Germany) [1-2] allow overcoming common soft tissue problems of conventional socket fixation and provide better control of the prosthetic limb [3], higher mobility and comfort [2, 4]. However, restraining issues such as soft-tissue infections, peri-prosthetic bone fractures [3, 5-8] and considerable bone loss around the stem [9], which might lead to implant's loosening, are present. Finally, a long a residual limb is required for implant fitting.

In order to overcome the limiting biomechanical issues of the current designs, a new concept of the direct intramedullary fixation was developed. The aim was to restore the natural load transfer in the femur and allow implantations in short femur remnants (Figure 1). We hypothesize that the new design will reduce the peri-prosthetic bone failure risk and adverse bone remodeling.

Generic CT-based finite element models of an intact femoral bone and amputated bones implanted with 3 analyzed implants were created for the study. Models were loaded with two loading cases from a normal walking obtained from the experimental measurements with the OPRA device [10-11]. Periprosthetic bone failure risk was evaluated by considering the von Mises stress criterion [12-14]. Subsequently the strain adaptive bone remodeling theory was used to predict long-term changes in bone mineral density (BMD) around the implants. The bone mineral content (BMC) change was measured around implants and the results were visualized in the form of DXA scans.

The OPRA and the ISP implants induced the high stress concentration in the proximal region decreasing in the distal direction to values below physiological levels as compared with the intact bone. The stresses around the new design were more uniformly distributed along the cortex and resembled better the intact case. Consequently, the bone failure risk was reduced as compared to the OPRA and the ISP implants. The adaptive bone remodeling simulations showed high bone resorption around distal parts of the OPRA and the ISP implants in the distal end of the femur (on average -75% ISP to -78% OPRA after 60 months). The bone remodeling simulation did not reveal any bone loss around the new design, but more bone densification was seen (Figure 2). In terms of total bone mineral content (BMC) the OPRA and the ISP implants induced only a short-term bone densification in contrast to the new design, which provoked a steady increase in the BMC over the whole analyzed period (Figure 3).

In conclusion, we have seen that the new design offers much better bone maintenance and lower failure probability than the current osseointegrated trans-femoral prostheses. This positive outcome should encourage further developments of the presented concept, which in our opinion has a potential to considerably improve safety of the rehabilitation with the direct fixation implants and allow treatment of patients with short stumps.

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Figures

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Figure 6

Does Incising the Quadriceps Tendon During Primary Total Knee Arthroplasty Affect the Recovery of Early Postoperative Ambulatory Function?

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Does incising the quadriceps tendon during primary total knee arthroplasty affect the recovery of early postoperative ambulatory function?

INTRODUCTION:

Clinical trials have generally failed to demonstrate superior clinical effectiveness of minimally invasive surgical approaches for total knee arthroplasty (TKA). The hypothesis of the current study was that avoiding incision of the quadriceps tendon would result in a significantly faster recovery of ambulatory function after total knee arthroplasty, compared to a technique that incised the quadriceps tendon.

METHODOLOGY:

The MIKRO (Minimally Invasive Knee Replacement Outcomes) Study is a prospective, level 1 RCT that enrolled 128 patients with knee osteoarthritis who had failed non-operative treatment, and had decided to proceed with TKA. After skin incision, 64 patients each were randomized to either a subvastus (SV) or medial parapatellar arthrotomy (MPPA) approach. All surgeries were done with the same TKA implant, with anesthesia, post-operative analgesia, and physical therapy standardized for both groups. A Patient Diary methodology was used as the primary outcome measure for ambulatory function. During the first 8 weeks after TKA, a research assistant blinded to treatment assignment telephoned each patient and completed study forms that documented indoor and outdoor walking relative to use of ambulatory devices, as well as Knee Society Score (KSS) and the UCLA activity scale. The UCLA score and change in KSS from baseline at 4- and 12-week follow-up were used to begin the validation process for an Ambulatory Function Score (AFS) derived from diary indoor and outdoor scores.

RESULTS:

There was a trend for the SV group to report more independent ambulation than the MPPA group at week 1 after

surgery, as indicated by self-reported AFS ($p < .052$). Both treatment groups demonstrated significant week to week AFS gains through 5 weeks, after which weekly changes were minimal. As expected, outdoor AFSs were initially slower to improve than indoor AFSs, but by 6 weeks the initial 20-pt difference was less than 10-pts. AFS scores were significantly correlated with UCLA scores across all 8 weeks. Knee Society Scores (KSS) at baseline were rarely correlated with AFS scores across the 8 weeks. However, 1-month and 3-month KSS scores were significantly correlated with AFS scores at $p < .05$ beginning with weeks 2 or 3 and through week 8.

CONCLUSION:

Avoiding incision of the quadriceps tendon during primary TKA resulted in a short-lived trend of quicker improvement in the AFS score in the SV TKA group versus the MPPA group. However, there appeared to be a similar rate of subsequent AFS improvement across the subsequent 8 weeks between the two groups. Preliminary results suggest a pattern of results – general improvement across 5-6 weeks that was maintained through the 8 weeks of evaluation, and significant correlations with UCLA and KSS scores after 2-3 weeks – that are consistent with the notion that the AFS is sensitive to change, and is variable depending on context (indoor vs. outdoor ambulation). Although related to UCLA and KSS scores, observed correlation magnitudes were not so high as to suggest that UCLA or KSS scores might be reasonable proxies for AFS.

3B : Hip mechanics: #786 September 21st, 2011, 13:50-14:40

Long-Term Assessment of Cement Fixation in Acetabular Replacements Under Physiological Testing in a Biological Environment

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Introduction

Damage development in cemented acetabular replacements has been studied in bovine pelvic bones under long-term physiological[1] loading, albeit dry, conditions, using a specially designed hip simulator[2]. In this work we report further experimental results from testing in wet condition in a new custom designed environmental chamber. Damage was detected and monitored using mCT scanning at regular intervals of the experiments. Two dimensional projections in the axial, sagittal and coronal planes were extracted from the 3D data for fatigue damage identification. The simulated mechanical and biological effects on the initiation and evolution of the damage of cemented acetabular reconstructs were examined and compared with those under dry condition.

Materials and methods

Bovine bones were treated and reamed to receive a cemented polyethylene cup (Charnley ogee, Depuy Int) in the standard position. Standard cementing technique was utilised to apply the cement (CMW1,DePuy CMW) into the socket, with an average cement mantle thickness of 2-3 mm. The combined loading block included four routine activities, as measured by Bergmann et al.[1], was programmed into a specially designed 4-station hip simulator for endurance testing of cement fixation[2]. A body weight of 125 kg was assumed to represent an upper bound load case and to accelerate the tests. A custom made environmental chamber (Fig. 1) was designed and built to accommodate saline solution (0.9% NaCl), where the temperature was kept constantly at 37°C. The implanted bone samples were removed from the test rig at regular intervals (100,000 and 200,000 cycles) and examined using a mCT scanner.

Results and discussion

For the tests under dry condition[2], μCT images showed progressive development of radiolucent lines, usually in the superior-posterior quadrant near the dome region which led to gross failure; and the number of cycles to failure seems to be related to the type of physiological loadings in that the worst case was found to be descending stairs, followed by combined loading and normal walking. For the tests conducted under wet condition, debonding was detected at the bone-cement interface along the rim of the acetabulum (Fig. 2), as opposed to near the dome in the cases under dry condition. Under the same load magnitude, the survival life in cycles under wet condition is also drastically reduced (~200,000) compared to ~ 2,000,000 in dry condition.

Conclusion

Preliminary endurance testing in physiological wet condition seems to suggest that interfacial debonding at the bone-cement interface near the rim is responsible for earlier crack initiation and failure of the acetabular fixation, as opposed to debonding near the dome region in dry condition.

Acknowledgements

DePuy CMW for providing bone cement; Mr C Lupton for assistance in the experiments.

References

[1] Bergmann G. *et al*., J. Biomech. 34:859-872, 2001

[2] Wang J-Y *et al*., J. Biomech. 42: 1061-1068, 2009

Figure captions

Fig. 1: Schematic representation of the experimental setup. The sample was first fixed onto the base plate (a). The chamber was mounted around the specimen (b), which was then immerged in saline solution (c).

Fig. 2: CT images of bone-cement interfacial damage evolution in an acetabular reconstruct under wet condition after a) 100,000 and b) 200,000 cycles.

Figures

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Figure 4

15B : Bearing materials: #679 September 23rd, 2011, 14:50-15:40

Improvement of Lubricating Ability by the Surface Polishing of Hip Prostheses

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Fluid film lubricating ability of a total hip prosthesis depends on the profile accuracies including surface-roughness or the sphericity of a head or a cup. Therefore, surface polishing is important. It was, however, difficult to polish the central portion of a cup or head using the conventional rotating machine. In the present study, we developed a polishing method combining a pendulum machine and a robotic arm. The effect of the accuracy improvement by this method was evaluated by the friction measurements on some test specimens.

Nine balls and a cup of Co-Cr-Mo alloy that were polished by a conventional process using a rotating machine were prepared for the prototype. The average diameter of the balls was 31.9648 mm with the sphericity of 0.0028 μm. The inside diameter of the cup was 31.9850 mm with the sphericity of 0.0044 μm. We combined a robotic arm and a pendulum apparatus to enable the further polishing. The ability of both automatic centering and change in the sliding direction was accomplished by this system. The sliding direction has been changed 180 times every ten degrees. The total distance of polishing was 120 m under vertical load of 100 N in a bath of saline solution containing abrasive grains of silicate of the diameter of 2μm. The surface roughness of the central portion of the cup, which is important area for the fluid film lubrication decreased from *Ra* 20.2 μm before the polishing to *Ra* 18.7 μm after the polishing.

A pendulum type friction tester was used for the assessment of the improvement of the lubricating ability by the polishing. The measurement was run over at 10 times under the conditions of the load of 600 N in a bath of saline solution. As the result, the frictional coefficients decreased from 0.1456-0.1720 before polishing to 0.1250-0.1300 after polishing. The polishing effect was, however, observed only at the specimens that radial clearances did not

exceed the value of 50 μm.

The present results indicated that the surface polishing of the central portion of hip prostheses must improve the lubrication ability and the radial clearance before the finishing process should be chinked as possible.

Key Words: Hip prosthesis, Fluid film lubrication, Polishing, Radial clearance, Profile accuracy

1B : MIS - Hip: #403 September 21st, 2011, 8:30-9:35

A Prospective Comparison of Minimally Invasive Direct Anterior Versus Posterior Total Hip Based Upon Inflammation and Muscle Damage Markers

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Background:

The anterior approach for total hip arthroplasty has recently been hypothesized to result in less muscle damage. While clinical outcome studies are essential, they are subject to patient and surgeon bias. We prospectively analyzed biochemical markers of muscle damage and inflammation in patients receiving anterior and posterior minimally-invasive total hip arthroplasty to provide objective evidence of the surgical insult.

Methods:

29 patients receiving an anterior and 28 patients receiving a posterior total hip arthroplasty were analyzed. Peri-operative and radiographic data were collected to ensure similar cohorts. Creatine kinase, C-reactive protein, Interleukin-6, Interleukin-1beta, and Tumor necrosis factor-alpha were collected pre-operatively, post-operatively, and on post-operative days 1 and 2. Comparisons between the groups were made using the Student's t-test and Fisher's Exact test. Independent predictors of elevation in markers of inflammation and muscle damage were determined using multivariate logistic regression analysis.

Results:

Markers of inflammation were slightly decreased in direct anterior group (mean differences in C-reactive protein 27.5 [95% confidence interval -24.7 - 79.6] mg/dL, Interleukin-6 13.5 [95% confidence interval -11.5 - 38.4] pg/ml, Interleukin-1beta 42.6 [95% confidence interval -10.4 - 95.6], and Tumor necrosis factor-alpha 148.6 [95% confidence interval -69.3 - 366.6] pg/ml). The rise in creatine kinase was 5.5 times higher in the post anesthesia care unit (mean difference 150.3 [95% confidence interval 70.4 - 230.2] units/L, $p < 0.05$) and nearly twice as high cumulatively in the miniposterior approach group (305.0 [95% confidence interval -46.7 - 656.8] units/L, $p < 0.05$).

Conclusion:

Anterior total hip arthroplasty caused significantly less muscle damage compared to traditional posterior surgery as indicated by creatine kinase levels. The clinical importance of this rise needs to be delineated by further clinical studies. The overall physiologic burden as measured by markers of inflammation, however, appears to be similar. Objective measurement of muscle damage and inflammation provides an unbiased way of determining the immediate effects of surgical intervention in total hip arthroplasty patients.

Plenary session 2 : Award Session: #1072 September 22nd, 2011, 9:45-10:30

In Pursuit of Fluid Film Lubrication

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Lifetime achievement award 2011

In pursuit of fluid film lubrication

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Investigation of how natural joints functioned seemed closely dependent on the lubrication mechanisms involved. This was equally relevant to artificial joints where, if fluid-film lubrication could be generated, the rubbing surfaces would be completely separated by the liquid film which would have the advantage of reducing friction, since this depends only on the shearing of the lubricant film, and reducing wear since the two surfaces would not be touching.

In 1969 when I first entered this research area, hip joints were mainly small diameter (<32mm) made from ultra high molecular polyethylene (UHMWPE) rubbing against stainless steel or cobalt chromium molybdenum alloy (CoCrMo), metal-on-metal joints and alumina-on-alumina joints. A few calculations showed that the small diameter metal-on-metal hips and the UHMWPE acetabular components in combination with any type of head material were unable to produce fluid-film lubrication. Insufficient film-thicknesses could be generated to separate the rough surfaces of the joints so surface-to-surface contact prevented full separation.

Ceramic-on-ceramic was different. This could be polished very smoothly and was hydrophilic so it could draw the water based lubricants (synovial fluid), into the contact region, which in turn generated fluid-films. This meant that with alumina-on alumina, wear was not a problem-but fracture was in some circumstances.

As more was learned about lubrication, large diameter CoCrMo hip resurfacing devices became possible. Whilst small diameter metal-on-metal hip joints were unable to generate fluid-film lubrication, larger diameter hips could, provided the lubricant contained serum (similar to synovial fluid). This was interesting since water based lubricants of similar rheology to synovial fluid (carboxy methyl cellulose, CMC) could not produce fluid-films (Figure 1) even though theory suggested that they should. Thus it was assumed that the proteins present in the natural lubricant were important, but the reason was unknown.

Returning to the original assumptions of Osborne Reynolds in deriving the theory of hydrodynamic lubrication, we see that in order to draw fluid into the contact area, the fluid adjacent to the solid boundary was assumed to be travelling at the same speed as the boundary itself. To do this the lubricant must ‘wet’ the surface or attach to it- but what if the surfaces are hydrophobic? The speed of drawing the fluid into the contact will be lower than the surface speed and so less fluid will be drawn in and the pressure generated will be lower than predicted by theory. So a simple experiment was tried using a large diameter CoCrMo alloy hip resurfacing device where a water-based lubricant (CMC) first had bovine serum added, then a simple detergent to reduce the surface tension. Figure 1 shows clearly that the lubrication improves markedly with the detergent – even more so than the bovine serum. This suggests that the wettability of the surfaces is important.

Another approach to enhancing fluid-film lubrication stems from the concept of elasto-hydrodynamic theory. Here, lower modulus, more compliant surfaces, produce thicker fluid-films for similar entraining velocities and applied loads. Thus we developed compliant hip and knee joints using hydrophilic poly carbonate urethane (PCU) acetabulae against metals or ceramics. These produced phenomenally low coefficients of friction (circa 0.001) and in the knee, wear rates of only 0.06 mm^3/million cycles (two orders of magnitude lower than metal on UHMWPE).

Another interesting biomaterial is carbon-fibre reinforced poly-ether-ether-ketone (CFR-PEEK). Very long term hip simulator wear experiments (25 million cycles), showed wear rates which were lower than cross-linked polyethylene (circa 1.5 mm^3/million cycles), yet friction was very high (μ=0.2-0.3). Clearly this was not fluid-film lubrication but improvements are being investigated.

Figure 1:Friction factor for metal-on-metal hip resurfacing

1A : Kinematics and Wear-knee: #794 September 21st, 2011, 8:30-9:35

In Single-Radius Total Knee Prostheses a Mobile Insert Is Redundant: A Combined RSA and Fluoroscopy Study

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The mobile-bearing variant of a single-radius design is assumed to provide more freedom of motion compared to the fixed-bearing variant because the insert does not restrict the natural movements of the femoral component. This would reduce the contact stresses and wear which in turn may have a positive effect on the fixation of the prosthesis to the bone and thereby decreases the risk for loosening. The aim of this prospective randomized study was to evaluate early migration of the tibial component and kinematics of a mobile-bearing and fixed-bearing total knee prosthesis of the same single-radius design.

According to a prospective randomized protocol 20 Triathlon single-radius posterior- stabilized knee prostheses were implanted (9 mobile-bearing and 11 fixed-bearing). Fluoroscopy and roentgen stereophotogrammetric analysis were performed 6 and 12 months post-operatively.

The 1 year post-operative roentgen stereophotogrammetric analysis results showed considerable early migrations in 3 mobile-bearing patients and 1 fixed-bearing patient. The range of knee flexion was the same for the mobile-bearing and fixed- bearing group. The mobile insert was following the femoral component during motion.

This study showed no apparent distinction in early migration and kinematics between mobile-bearing and fixed-bearing single-radius total knee prostheses. Des- pite the mobile insert was following the femoral component during motion, and therefore performed as intended, no kinematic advantages of the mobile-bearing total knee prosthesis were seen. It is concluded that a mobile insert in single-radius total knee prostheses is redundant and will not lead to additional benefits.

13B : Hip arthroplasty: #724 September 23rd, 2011, 11:15-12:05

Expectations and Outcome of a Scientifically Developed Hip Prosthesis

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In the present study we describe the clinical results of the Scientific Hip Prosthesis® (SHP). With the goal of smoothening cement-bone interface stress peaks, the SHP was developed using shape optimization algorithms together with finite element modelling techniques. The resulting shape and cement stresses are seen in Figure 1. The introduction of the SHP prosthesis was performed in a stepwise fashion including a RSA study performed by Nivbrant et al[1]. RSA studies for prosthetic types that are in long-term use are of great value in predicting the survivorship related to the migration rate and pattern for that specific type of prosthesis. If a stem in a patient shows a much higher migration rate than the typical one, the stem may be identified as at high-risk for early loosening. The study of Nivbrant et al[1] revealed unexpectedly high migration values and it was stated that the SHP stem was not the preferred stem to use despite the good Harris Hip Score and Pain score at two years

follow-up.

In the present study the clinical results of a single surgeon study consisting of 171 hips with a follow-up of 5-12 years were evaluated. The mean follow-up was 8.2 years (5.0-12.0). The survival rate was 98.8% at ten years follow-up for aseptic loosening of the stem. The mean Harris Hip Score at 10 year follow-up was 89.2 ± 7.5. This study therefore indicates that a new prosthetic design may function clinically rather well, despite the relatively high migration rates which have been reported.

In case of a RSA study with a new prosthesis it may not be so evident what the expected “typical” migration rate or pattern is. So in order to predict early loosening the typical migration rate has to be known. Perhaps typical migration rates can be established using standardized cadaver migration experiments or computer simulation models techniques. Since these standardized tools are currently not available, the prediction of clinical survival of new prosthetic components remains a challenging task and the interpretation of migration rates with new designs should be considered with much caution.

Nivbrant B, Kärrholm J, Soderlund P. Increased migration of the SHP prosthesis: radiostereometric comparison with the Lubinus SP2 design in 40 cases. Acta Orthop Scand 1999;70(6):569-577.

Figures

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Figure 2

What Are Safe Upper Limits in Well Functioning Resurfaced Hips?

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INTRODUCTION

Metal-on-metal hip resurfacing arthroplasty (MoMHRA) is a surgical option in the treatment of end-stage hip disease. The measurement of systemic levels of metal ions gives an insight into the wear occurring and is advocated by regulatory bodies as routine practice in the assessment of resurfaced hips. However, the acceptable upper levels of Chromium (Cr) and Cobalt (Co) ions concentration with clinical significance still have to be established. The aim of this study is to address this issue in unilateral and bilateral resurfaced hips.

METHODS

453 patients with unilateral MoMHRA and 139 patients with bilateral MoMHRA at >12 months postoperative were retrospectively identified from an independent hip specialist’s database. Routine metal ion levels were measured at last follow-up (ICPMS protocol). Radiological assessment included measurement of acetabular component orientation using EBRA, calculation of contact patch to rim (CPR) distance, and evaluation for any adverse X-ray findings. The cohort was divided into the well functioning group (Group A) and the non-well functioning group (Group B). A well functioning resurfacing gad to fulfil all of the following criteria (bilateral patients had to fulfil criteria for both hips): no patient reported hip complaints, no surgeon detected clinical findings, HHS> 95, CPR distance> 10mm, no abnormal radiological findings and no further operation scheduled. Upper levels (acceptable limits) of Cr/Co were considered to be represented by the top margin of the box-whisker plot [upper limit = 75^{th} quartile value + (1.5 x interquartile range)] in Group A.

RESULTS

251 unilateral MoMHRAs patients (55%) and 58 patients with bilateral MoMHRAs (42%) comprised Group A. The majority of males were in Group A compared to the majority of females who belonged in Group B ($p<0.001$); subsequently Group A patients had bigger size components ($p<0.001$). Unilateral Group A [Cr: 2.0 μg/l (SD: 1.5)/ Co: 1.8μg/l (SD: 1.2)] patients had significantly lower ions than Group B [Cr: 7.3μg/l (SD: 17.3)/ Co:

6.6μg/l (SD: 18.1)] patients (p <0.001). Similarly, Group A bilateral patients [Cr: 3.8μg/l (SD: 2.7)/ Co: 2.8μg/l (SD: 1.9)] had significantly lower ions that Group B [Cr: 10.7μg/l (SD: 16)/ Co: 8.5μg/l (SD: 15.8)].

The upper levels (safe were: Cr: 4.6μg/l / Co: 4.0μg/l for unilateral MoMHRAs and Cr: 7.4μg/l / Co: 5.0μg/l for bilateral MoMHRAs. Unilateral MoMHRAs had significantly higher ion levels compared to bilateral patients (p <0.001). Sensitivity and specificity of these upper levels in predicting poor function were respectively 25% and 95% for Cr and 22% and 96% for Co.

DISCUSSION

The findings of this study suggest that both unilaterally and bilaterally resurfaced patients with well functioning implants have low metal ion levels with upper levels of Cr: 4.6μg/l / Co: 4.0μg/l for unilateral MoMHRAs and Cr: 7.4μg/l / Co: 5.0μg/l for bilateral MoMHRAs These results indicate that the upper acceptable limit of metal ion levels in resurfaced hips is lower than the previously MHRA recommended threshold, however the study was conducted with very low tolerance for what was considered a clinically problematic hip. Well-functioning bilateral resurfacing have higher ion levels compared to well-functioning unilateral resurfacing.

4B : Hip resurfacing: #641 September 21st, 2011, 14:50-15:40

The Evolution of Ion Levels During Steady-State Wear in Resurfaced Hips

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Introduction

Tribological studies have described a characteristic wear pattern of metal-on-metal hip resurfacings (MoMHRAs) with a run-in period followed by a 'bedding-in' phase minimising wear or by an increasing wear patch with edge loading. The use of metal ions as surrogate markers of in-vivo wear is now recommended as a screening tool for the performance of MoMHRAs. The aims of this retrospective, single-surgeon study were to measure ion levels in unilateral MoMHRAs at different stages during the steady-state in order to study the evolution of wear and factors affecting it.

Methods

218 consecutive patients with minimum two serum ion measurements were included. The mean age at surgery was 52.3 years, the first assessment was made at a mean of 2.5 years (11 months – 8 years) and the last assessment at a mean of 4.6 years post resurfacing (2– 12 years). Ion level change was defined as Ion level at last assessment minus Ion level at first assessment. Ten different resurfacing designs were implanted, the majority being BHR (n=104), Conserve plus(n=55) and ASR (n=25). The median femoral component size was 50 mm (38 – 59mm). Radiological assessment of acetabular component orientation was made with EBRA.

Results

For the whole cohort a significant reduction in Chromium (Cr) levels between initial [2.6 μg/ml (SD: 6.8)] and last assessment [1.9 μg/ml (SD: 8.3)] was found (p= 0.004). Cobalt (Co) levels were similar at initial [1.7 (SD: 7.7)] and last [1.8 (SD: 10.6)] follow-up (p=0.78). Cr levels increased in 31% and Co increased in 46% of patients. There was a significant ion level increase in 5% of patients. There was no significant difference between genders (p= 0.4) or implant designs (p = 0.07), but a trend of higher ions at last follow up with the ASR implants in comparison to BHR and C+. Neither component size (p=0.4) nor acetabular orientation (p=0.46) correlated with change in ion levels. However, a CPR distance (contact patch-rim) of <10mm was associated with an increase in Cr levels over time (p= 0.042). Patients with increasing ion levels had significantly lower Harris Hip Scores (p=0.038).

Discussion

The analysis of the evolution of ion levels in unilateral hip resurfacing after the run-in phase demonstrates an overall decrease of Cr levels but no significant change in Co levels. This in vivo finding is consistent with tribocorrosion studies showing the formation of a passive protective film on the articulating surfaces after the initial wear-in, preventing further corrosion. From that point on, provided there is no edge loading causing increased surface wear, ions are mainly formed by corrosion of the particulate debris generated during the run-in phase. In vitro studies have shown a higher dissolution of the more soluble Co from the debris while Cr remains in solid form with less ion formation. In a number of cases in our study, ion levels continued to increase, indicating ongoing surface wear. These increasing ion levels were correlated with a lower coverage angle more

prone to edge loading and with the development of clinical symptoms.

6B : Survival / Outcome: #699 September 22nd, 2011, 8:30-9:35

Implant Survival of Metal-on-Metal Hip Resurfacing. a Systematic Review of the Published Literature

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Introduction:

Hip resurfacing arthroplasty (HRA) has seen a recent revival with third generation Metal-on-Metal prostheses and is now widely in use. However, safety and effectiveness of hip resurfacing are still questioned. We systematically reviewed peer-reviewed literature on hip resurfacing arthroplasty to evaluate implant survival and functional outcomes of hybrid Metal-on-Metal hip resurfacing Arthroplasty.

Method:

Electronic databases and reference lists were searched from 1988 to September 2009. Identified abstracts were checked for inclusion or exclusion by two independent reviewers. Data were extracted and summarized by one reviewer and verified by a second reviewer. Main study endpoint was implant survival, which we compared with the National Institute of Clinical Excellence (NICE) benchmark. We also evaluated radiological and functional outcomes, failure modes and other adverse events.

Results:

We identified 433 articles, of which 24 met the inclusion criteria. Data were extracted from these 24 articles, totalling 8745 resurfaced hips, providing details on five out of 11 resurfacing devices on the market. Maximum follow up was 9 years, mean follow up ranged from 0.6 to 8 years. Implant survival ranged from 88.7% to 100%. Of the 8745 hips, 276 were revised (3.2%), with fracture of the femoral neck as most frequent failure mode. With implant survival plotted against time, 10 studies showed satisfactory implant survival percentages compared to the 3 year NICE entry-benchmark. Nine of these 10 studies used the BHR implant, the other study used the Cormet 2000 implant.

Discussion:

None of the HRA implants used to date meet the full 10 year NICE benchmark (≥ 90% survival at 10 years follow up). If follow up is too short for the full benchmark, implants are still recommendable if they meet the NICE three year 'entry benchmark' (> 3 year revision rate experience, consistent with the 10-year benchmark). Compared to the 3 year NICE entry-benchmark, 10 studies showed satisfactory implant survival percentages. Nine used the BHR implant, the other study used the Cormet 2000 implant. The quality of evidence is low according to the GRADE classification. Future research has to address the most important failure mode for HRA trying to explain the large variation in the frequency of femoral neck fractures.

3A : Navigation: #940 September 21st, 2011, 13:50-14:40

The Use of Patient Specific Instruments in TKA Is Beneficial for the Patient, the Surgeon and the Health Care System.

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Total Knee Artroplasty (TKA) is becoming more and more popular, even in the younger active age group. In this age group however the results are not that reproducible as in the older age group. People are more limited in their activities of daily living and complain more about pain, stifness and swelling. At the end and in general the younger age group is less satisfied than the older patients.

The last decade minimal invasive solutions with modified instruments, Gender Knees, the use of navigation in TKA, ligament-based techniques, fast rehab protocols etc have all been introduced to make the results of TKA

better. These are all elements that indeed can make the patient better. However the most important on the short term and the long term is the use of the correct implant size and the correct implantation of the prosthetic components.

Since January 2011 we routinely use patient specific instruments in TKA patients under 60y that are very active or in older less active patients with important anatomic malformations. A CT-based system that scans the hip-knee-ankle is used. The data are sent to an engineer and a digital proposal is sent back to the surgeon that can approve the different measurements performed. Once approved the patient specific cutting blocks are sent to the surgeon. In our department we use the Advance Medial Pivot Knee System as our standard knee system since its introduction thirteen years ago. Since then more than 2000 implantations have been performed. This experience has made it possible to critically evaluate the patient specific cutting block technique.

The first results are very satisfying.
During surgery less ligamentous releases had to be performed, there was in all cases an optimal patellofemoral tracking without any release, there was less blood loss and surgery time was decreased. At all times during surgery we were very satisfied how we could verify all surgical steps and this is in our opinion very important. During the first postoperative days the patients experienced less pain (routine VAS recorded), there was a faster return to full ROM and patients asked to go home earlier.

After two months patients are routinely followed up and they undergo a clinical and radiographic exam.
All prosthetic components were implanted the way we had planned it. The overall axes were restored and up till now no complications were noticed.
All patients experienced a fast recovery with full ROM at 2 months, no complaints about pain or swelling and very interestingly no residual intra-articular swelling which is often seen in these active and younger patient group. Patients are also asked to fill in a patient-based outcome measurements (KOOS) questionnaire.

In our opinion it is a very easy and promising system for the experienced surgeon. Younger and less experienced surgeons however should be warned that they cannot blindly trust the system. We surgeons have to control what the engineer has proposed before and during surgery.

4B : Hip resurfacing: #1082 September 21st, 2011, 14:50-15:40

No Clear Benefits Seen in Hip Resurfacing Compared With THA

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Hip Resurfacing – No clear benefit seen in hip resurfacing compared with THA

Introduction Modern metal-on-metal hip resurfacing (RHA) was introduced as a bone-preserving method of joint reconstruction for young and active patients; however, the large diameter of the bearing surfaces is of concern for potentially increased metal ion release.

Patients and methods 71 patients (< 65 yrs) were randomly assigned to receive either a RHA (n=38) or a conventional metal-on-metal (MoM) THA (n=33). Functional outcomes were assessed preoperatively, at 6, 12 and 24 months. Cobalt and chromium blood levels were analyzed preoperatively, at 3, 6, 12 and 24 months.

Results All functional outcome scores improved highly significant for both groups. At 12 and 24 months the UCLA Activity score was significantly higher for the RHA patients, the OHS only at 24 months. However, in spite of randomization UCLA scores also appeared to be higher in RHA patients at baseline. RHA patients were more satisfied at 12 months. Cobalt concentrations were significantly higher for RHA only at 3 and 6 months. Chromium levels remained significantly higher for RHA until 24 months. No pseudotumors were encountered in either group so far. One RHA was revised for early aseptic loosening and in two THA's a cup insert was exchanged for recurrent dislocation.

Conclusion RHA patients scored significantly higher on UCLA, OHS and satisfaction at some intervals, however, as for the UCLA preoperative levels were already in favor of RHA. Chromium blood levels were significantly

higher for RHA, whereas for cobalt this was only observed up to 6 months. The true value of RHA against THA will be determined by longer follow-up and a possible shift of balance between their respective (dis)advantages.

14A : Patella: #1083 September 23rd, 2011, 13:50-14:40

Is There a Biomechanical Explanation for Anterior Knee Pain in Patients With Patella Alta?

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Is there a biomechanical explanation for anterior knee pain in patients with patella alta?

Influence of patellar height on patellofemoral contact force, contact area and contact pressure.

ABSTRACT

The prevalence of anterior knee pain in the general population is relatively high. Patellar height, and more specific patella alta, is one of the several factors that have been associated with anterior knee pain, but the precise mechanism by which patella alta leads to a less favourable situation in terms of patellofemoral contact force, contact area and contact pressure, is poorly understood. The recent availability of validated dynamic knee simulators and advances in the analysis of contact force and area, give us today the possibility to study the influence of patellar position and patellar height on patellofemoral biomechanical characterisitics. Simulating a knee squat in different configurations with variable predetermined patellar height, reveals a clear association of patella alta with the highest maximal patellofemoral contact force and contact pressure, probably as a consequence of the delay in tendofemoral contact. When averaged across all flexion angles, the normal height of the patella seems to be the most optimal position in terms of contact pressures. This may provide a biomechanical explanation for anterior knee pain in young patients with patella alta and in older patients following total knee prosthesis resulting in an altered patellar position in terms of height.

15A : Alternative treatments: #1133 September 23rd, 2011, 14:50-15:40

Scaffolds or Allografts for Meniscal Replacement?

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No abstract available

Keynote Lecture 4 : Understanding Human Anatomy: Insights From Comparative Biomechanics by Evie Vere: #635 September 21st, 2011, 13:35-13:50

Understanding Human Anatomy: Insights From Comparative Biomechanics

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A good understanding of musculoskeletal pathologies not only requires a good knowledge of normal human anatomy but also an insight in human evolution and development. Biomechanical studies of the musculoskeletal system have greatly improved our understanding of the human musculoskeletal system via medical imaging, modeling and simulation techniques. The same techniques are, however, also used in the study of nonhuman species and a comparison of human and nonhuman data can yield interesting insight in form-function relationships and mechanical constraints on motion.

Anatomical and biomechanical studies on dogs and rabbits have already yielded valuable insight in disease mechanisms and development of musculoskeletal pathologies such as osteoarthritis (OA). Nonhuman primates have, however, rarely been studied in this context, though they may prove particularly valuable as they can provide us with an evolutionary context of modern human anatomy and pathology. The high prevalence of osteoarthritis in modern humans and its rare occurrence in wild primates has previously been explained as due to human joints being ‘underutilized’ or ‘underdesigned’. Modern humans are highly specialized for bipedalism, while nonhuman primates typically use a wide range of locomotor modes and joint postures to travel through the three-dimensionally complex forest canopy. These hypotheses can, however, be challenged, as it seems more likely that

the low occurrence of OA in wild primates is due to a combination of underreporting of the disease and absence of the ageing effect in these species. Our understanding of musculoskeletal function and disease in modern humans would clearly benefit from more studies investigating the occurrence and characteristics of OA in nonhuman primates.

12B : Hip arthroplasty: #612 September 23rd, 2011, 8:30-9:35

Long-Term Results of the Alloclassic Zweymueller Total Hip Prosthesis in Patients Younger Than 50 Years

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Introduction

Total hip arthroplasty in young patients is still associated with high failure rates, especially at the acetabular side. Purpose of this study was to evaluate the long-term results of the Alloclassic cementless Zweymüller total hip prosthesis in patients younger than 50 years at the time of surgery.

Methods

Between 1987 and 1994, 73 Zweymüller total hip arthroplasties with a titanium threaded cup were placed in 67 patients younger than 50 years. Mean age at surgery was 43 years (23 – 49 years). Patients were followed clinically with use of the HHS, revisions were determined and radiographs were analyzed. Kaplan-meier analysis was used to determine survival for different endpoints.

Results

Three hips were revised for septic loosening, 3 cups for aseptic loosening and 1 hip because of periprosthetic fracture. Four patients (4 hips) died and 8 patients (9 hips) were lost to follow-up without any revision. 48 patients with 53 prostheses could be evaluated after a mean follow-up of 208 (170 - 253) months and the mean HHS was 90 (52 – 100). Cumulative survival analysis with endpoint revision for any reason was 89% (C.I. 85 - 93) at 17 years. With endpoint aseptic loosening, survival was 95% (C.I. 91 – 98) at 17 years.

Conclusion

Alloclassic Zweymüller total hip arthroplasty with a titanium threaded cup showed good long-term results, even in this group of patients younger than 50 years.

5A : Knee mechanics: #1134 September 21st, 2011, 16:20-17:10

Virtual 3D Planning and Patient Specific Cutting Blocks for Osteotomies

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Introduction

Osteotomies around the knee are traditionally templated on 2D plain X-rays. Results are often inaccurate and inconsistent and multiplanar ostetomies are hard to perform. The aim of this study is to evaluate the feasibility and accuracy of virtual three-dimensional CT-based planning and correct execution of osteotomies around the knee with the aid of patient specific surgical guides and locking plates.

Methods

Eight consecutive patients with significant malalignment of the lower limb were included in the study. Pre-operative CT scans of the affected limb and the normal contra-lateral side were obtained and 3D models of the patient's anatomy were created, using dedicated software. The healthy contralateral limb was mirrored and geometrically matched to the distal femur or proximal tibia of the healthy side. A virtual opening wedge correction

of the affected bone was used to match the geometry of the healthy contralateral bone. Standard lower limb axes measurements confirmed correction of the alignment. Based on the virtual plan, surgical guides were designed to perform the planar osteotomy and achieve the planned wedge opening and hinge axis orientation. The osteotomy was fixed with locking plates and screws. Post-operative assessment included planar X-rays, CT-scan and full leg standing X-rays.

Results

One three-planar, three bi-planar and four single-plane osteotomies were performed. Maximum weightbearing mechanical femoro-tibial coronal malalignment varied between 7° varus and 14° valgus (mean 7.6°, SD 3.1). Corrective angles varied from 7°-15°(coronal), 0°-13°(sagittal) and 0°- 23°(horizontal). The maximum deviation between the planned pre-operative wedge angle and the executed post-operative wedge angle was 1° in the coronal, sagittal and horizontal plane. The desired mechanical femorotibial axis on full-leg standing X-rays was achieved in 6 patients. Two patients were undercorrected by 1° and 2° respectively.

Conclusion

3D planning and guided correction of multi-planar deformity of femur or tibia is a feasible and accurate novel technique.

15A : Alternative treatments: #590 September 23rd, 2011, 14:50-15:40

Magnetic Nanoparticles and Mesenchymal Stem Cells: The Future of Orthopaedics.

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MSCs (mesenchymal stem cells) are bone marrow-derived cells capable of replication and differentiation *in-vitro* into several tissues including bone, cartilage, stroma, fat, muscle and tendon. MSCs can be isolated by relatively simple procedures and then expanded without losing the ability to differentiate into multiple lineages. As such, these cells have immense clinical potential in regenerative medicine and in orthopaedics for repair or replacement of damaged tissues. In this work we investigated the interaction between magnetic carbon nanotubes (CNTs) and MSCs and their ability to guide these cells injected intravenously in living mice by using an external magnetic field. CNTs did not affect cell viability and their ability to differentiate. Both the CNTs and the magnetic field did not alter cell growth rate, phenotype and cytoskeletal conformation. CNTs, when exposed to magnetic fields, are able to shepherd MSCs towards the magnetic source *in vitro*. Moreover, the application of a magnetic field alters the biodistribution of CNT-labelled MSCs after intravenous injection into rats. We demonstrated that CNTs hold the potential for use as nano-devices to improve therapeutic protocols for transplantation and homing of stem cells *in vivo*. This could pave the way for the development of new strategies for manipulation/guidance of MSCs in regenerative medicine and cell transplantation for the treatment of many orthopaedic diseases.

15A : Alternative treatments: #997 September 23rd, 2011, 14:50-15:40

Tuning Crosslinked Poly-HEMA-Co-MMA Hydrogels for Use in Articulating Situations

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In search for appropriate materials of potential use to relieve injured articular cartilage, we explored copolymers from HEMA (2-hydroxy-methyl-methacrylate) and MMA (methyl-methacrylate). Such copolymers can be synthesized by thermal or photochemical induced polymerization reaction. The water uptake by swelling to homogeneous hydrogels can easily be controlled by varying the mixing ratio of the hydrophilic (HEMA) and hydrophobic (MMA) monomer, and the nature and amount of added crosslinker (typically EGDA, ethyleneglycol-dimethacrylate). Essentially the same variables strongly influence the mechanical properties, i.e.

modulus (stiffness), relaxation response, as well as tribological behavior.

The polymer samples were engineered in molds from degassed formulations containing various amounts of HEMA and MMA, 10 % deionized water, and 0.01 % AIBN for thermal polymerization (12 h @ 70°C) or 0.5 % Darocur 1173 (2-hydroxy-2-methyl-1-phenyl-propane-1-one, for photopolymerization, 360 nm UV radiation, 5 to 7 min, sample thickness up to 5 mm). The samples were immersed in saline buffer after curing to allow free swelling to the equilibrium water content (EWC). Subsequently, samples were mechanically and tribologically tested. The mechanical moduli were determined at different strains and as a function of MMA content using a Zwicki Z5.0 (Zwick-Roell, Ulm, Germany). Tribological versus cartilage tissue was performed on an in-house-built pin-on-plate setup. Flat polymer samples were mounted and tested versus fresh porcine osteochondral grafts, harvested from humeral heads.

Mechanical testing revealed that the elastic modulus of pHEMA can be tuned as a function of MMA (0-50%) with 1 to 2 % bifunctional crosslinker to values ranging between 0.5 to 50 MPa, and corresponding water content of 40 to 10 % (decreasing with increasing MMA content). Friction measurements revealed a very low friction coefficient of around 0.02 for pHEMA-cartilage pairings. The values are 2-5 fold smaller than typical values of CoCrMo or UHMWPE versus cartilage.

Hydrogels from HEMA and MMA as main constituents are already rather well known for their biocompatibility. Knowledge of the dependence of e.g. the mechanical properties from chemical composition and polymer network structure makes this system ideal to design anisotropic specimen with controlled macrostructure to be used for temporal or permanent implants.

11B : Implant fixation: #1045 September 22nd, 2011, 17:40-18:30

Micromechanics of the Cement-Bone Interface and Its Consequences on Failure of the Complete Cemented Hip Reconstruction

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In cemented total hip arthroplasty, the cement-bone interface can be considerably degraded in less than one year *in-vivo* service (Figure 1). This makes the interface much weaker relative to the direct post-operative situation. Retrieval studies show that patients do, to a certain extent, not suffer from the degraded cement-bone interface itself. It is, however, unknown whether the degraded cement-bone interface affects other failure mechanisms in the cemented hip reconstruction. A good understanding of the mechanics of the cement-bone interface is therefore essential. The aim of this study was to investigate the mechanics of the cement-bone interface in the direct post-operative and degraded situation by the utilization of finite element analysis (FEA) and laboratory experiments. It was subsequently analyzed how the mechanics of the cement-bone interface affect failure of the cement mantle in terms of crack formation.

In order to investigate the mechanical response of the cement-bone interface, laboratory prepared (direct post-operative state) and postmortem (degraded state) specimens were loaded in various directions in the laboratory and FEA environment. From all specimens, multiple interface morphology parameters were documented, which were related to the interfacial response and subsequently converted to a numerical cohesive model. As a validation, this cohesive model was implemented into two FEA models of transverse sections of cemented hip reconstructions with distinct mechanical characteristics (Figure 2). Finally, the differences in fatigue crack formation in a complete hip reconstruction were determined by varying the cement-bone interface compliance (Figure 3).

When loaded in multiple directions, the interface compliance could not be related to the cement interdigitation depth (r^2=0.08). However, compliance did correlate to the gap thickness between the bone and cement (r^2=0.81) and the amount of interfacial contact (r^2=0.50). Surprisingly, for the same amount of contact, the interface was more

compliant in degraded state than in the direct post-operative state. The mechanical response of the experimental and FEA cement-bone interface tests could, independent on the direct post-operative or degraded state, successfully be described by a cohesive model. The cohesive model was even more confirmed by the successful reproduction of the mechanics of the retrieved transverse sections. When the cohesive model was implemented in a complete reconstruction, we found that a compliant cement-bone interface resulted in considerably more fatigue cracks in the cement mantle than a very stiff interface.

This study showed that an increased compliancy of the cement-bone interface results in an increase of cement cracks in the cement mantle. It is therefore crucial to minimize the interfacial gaps and, as a result, increase the amount of contact between the bone and cement to generate a stiff cement-bone interface. It is, unfortunately, unknown how this well fixed interface can be maintained. We finally conclude that the derived cohesive model of the cement-bone interface can be used for multiple applications in orthopaedics, including pre-clinical of implants and patient specific studies of failed cemented reconstructions.

Figures

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Figure 3

8A : Knee arthroplasty: #957 September 22nd, 2011, 13:55-14:45

The Potential of Accelerometers in the Evaluation of the Stability of Total Knee Arthroplasty

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INTRODUCTION

Total Knee Arthroplasty (TKA) is a durable procedure which allows most patients to achieve a satisfactory functional level, but there can be instability under stressful conditions. Instability is one cause of early revision, often due to misalignment or inadequate ligament balancing. Persistent instability may cause elevated polyethylene wear. Lower levels of instability may cause patient discomfort with certain stressful activities. Hence quantifying instability may have an important role in the functional evaluation of TKA. Several previous studies showed that accelerometers have advantages in kinematic studies including low cost, ease of application, and application to any activity. The aim of this study was to demonstrate the use of an accelerometer attached to the anterior of the tibia, as an evaluation of knee stability of TKA patients. It was postulated that accelerations between TKAs and normal controls will be different, which could indicate abnormal TKA kinematics involving instability, especially for high intensity activities.

METHODS & MATERIALS

We tested 38 TKA knees in 27 patients, in the age range of 50-80 years, with a minimum follow up of 6 months; and 25 knees in 16 shoulder patients, who had no known knee pathology as age-matched controls. A tri-axial accelerometer was firmly attached to the anterior proximal tibia to measure 3-axis accelerations with a sample rate of 100 Hz. Four activities were tested;

1) Starting with the test leg, walk 3 steps then come to a sudden stop

2) Take one step forward with the non-tested leg and make a tight 90â€¦ turn towards the non- tested knee direction

3) Sit down for 3-4 seconds then stand back up

4) Step up on a 7" inches high box with the test leg, followed by the non-test leg. Then step down from the box with the test leg, followed by the non-test leg.

During the activities, the patients responded to a questionnaire on instability and pain for each activity. For each test at the time of foot impact, there was a high/low peak acceleration, the peak-to-valley being taken as the indicator. The mean total magnitude of the acceleration was compared between the TKA and control groups in the anterior-posterior direction using the Student's t-test. Statistical significance was at p-value < 0.05.

RESULTS

Activity	Group	N	Mean(units)	SD	P-value
Walking 3 steps then sudden stop	Control	25	1.06	0.57	0.07
	TKR	38	1.38	0.74	
Sit-to-stand	Control	24	0.36	0.45	0.99
	TKR	38	0.36	0.40	
Stepping Up/ Down	Control	25	1.85	0.62	0.01
	TKR	36	2.27	0.62	
Turning in non-tested knee direction	Control	24	0.67	0.29	0.00
	TKR	38	1.13	0.67	

Significant differences were seen between TKR and normal controls for stepping down, and for turning. Significance was close for a sudden stop. From the instability questionnaire, 15 knees had pain and 13 knees felt unstable, most of the pain and instability (13 and 11 respectively) while performing stepping up and down activity. This was followed by the sudden stop activity which had 8 painful and 6 unstable knees

DISCUSSION

The significant differences between TKR and normal control knees indicated that TKR did not restore normal kinetics, which could be due to TKR design, persistent muscle weakness or other factors.

ACKNOWLEDGEMENTS

Funded by New York University Medical School – NYU-Polytechnic Seed Grant Program.

12A : Knee Mechanics: #970 September 23rd, 2011, 8:30-9:35

The Case for Early Intervention Knee Replacement

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In the large majority of cases of knee osteoarthritis (OA), total knee replacement (TKA) is the selected treatment, due to its proven durability, satisfactory function and familiarity of surgeons. However in recent years there has been an increase in the numbers of uni-compartmental knees used (UKA), due to more favorable follow-up, improved designs and techniques, quicker and better patient recovery, and less hospitalization costs. Designs have been produced for even lesser invasive components than UKA, including simple spacers, with mixed results. Recently, several studies have been carried out on the wear patterns on the femoral and tibial condyles in OA, showing that the main areas of cartilage loss occur on the distal end of the femur, that area engaged in walking activities, and over a large proportion of the tibial plateau. A study we carried out on the bone pieces resected at TKA surgery showed that no less than 22% of the cases could have been done with a device which resurfaced only the medial side . That figure would have been higher if the patients had been treated earlier, before cartilage

wear and deformation had progressed. In a more recent study, we showed the progress of the wear of OA by analyzing MRI scans of 50 patients at various stages of OA. The cartilage wear occurred on areas which were initially the thickest on both the femur and the tibia. This was evidently associated with excessive contact stresses, while the menisci, if they had previously been spreading the load over a large area of the cartilage surfaces, were no longer functional. In this paper it is proposed that the treatment modality of OA could be carried out on a sliding scale, based on MRI analysis together with clinical factors including pain and disability. Early Intervention devices, including UKA, could be used much more frequently if the surgical technique was developed to be reliable, simple and reproducible. Specifically there is space for an Early Intervention device (EI) where only the distal end of the femur and the tibial surface are resurfaced. A design has been produced where a pocket is milled into the distal end of the femur to house a plastic runner, and a thin layer is resected from the proximal tibia for a metal plate with a special keel design. The advantages of such a design are ease of exposure, accurate and simple surgery, minimal tibial resection for long term fixation, reduced wear, and ease of restoration of the original joint line. The wear is assessed using a custom-made wear machine, while fixation is evaluated using FEA. It is proposed that such a device would add a valuable option for the treatment of symptomatic early OA where the functional level of the patient can be maintained, and the progress of OA possibly arrested.

3B : Hip mechanics: #1106 September 21st, 2011, 13:50-14:40

The Effect of Femoral Component Placement on Contact Stresses and Range of Motion of Resurfacing Arthroplasty of the Hip

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The 3D interplay between femoral component placement on contact stresses and range of motion of hip resurfacing was investigated with a hip model. Pre- and post-operative contours of the bone geometry and the gluteus medius were obtained from grey-value CT-segmentations. The joint contact forces and stresses were simulated for variations in component placement during a normal gait. The effect of component placement on range of motion was determined with a collision model. The contact forces were not increased with optimal component placement due to the compensatory effect of the medialisation of the center of rotation. However, the total range of motion decreased by 33%. Accumulative displacements of the femoral and acetabular center of rotation could increase the contact stresses between 5-24%. Inclining and anteverting the socket further increased the contact stresses between 6-11%. Increased socket inclination and anteversion in combination with shortening of the neck were associated with extremely high contact stresses. The effect of femoral offset restoration on range of motion was significantly higher than the effect of socket positioning. In conclusion, displacement of the femoral center of rotation in the lateral direction is at least as important for failure of hip resurfacings as socket malpositioning.

10B : Bearings - hip: #1035 September 22nd, 2011, 16:40-17:30

Femoral Head Wear in Metal-on-Plastic Total Hip Replacments of Several Designs

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Sub-micron polyethylene wear particles have been identified as a cause of osteolysis frequently found in the bone surrounding total hip replacements (THR). However, the wear of the hard femoral components is much less understood and is often assumed to be negligible; yet, metal particulate and ionic debris are of rising clinical concern. This study investigates not only the wear rates of ultra high molecular weight polyethylene (UHMWPE) acetabular liners, but also the wear rates of metallic femoral heads in several THR designs and sizes, which until now have usually been ignored in this type of wear study.

Conventional UHMWPE liners (three 40mm, three 44mm I.D.), highly cross-linked (HXL) UHMWPE liners (three 40mm, three 44mm I.D.), and HXL UHMWPE liners with vitamin E blended (four 36mm and six 40mm

I.D.) were tested against CoCrMo femoral heads, appropriately sized and matched to the particular THR design, on a 12 station hip simulator (AMTI, Boston). The specimens were mounted in a physiologically correct manner on custom made fixtures, lubricated with bovine serum (20g/L protein, 37°C) and subjected to the walking cycle specified in ISO-14242-1 at 1Hz for 5 million cycles (Mc). The femoral heads and acetabular liners were carefully cleaned and gravimetrically weighed at standard intervals, and the wear was corrected with the weight gain of active load soak control heads and liners, and calibration weights.

The conventional UHMWPE liners showed the highest wear (40mm: 55.7±3.00mg/Mc, 44mm: 72.0±2.81mg/Mc) while HXL liners displayed much lower wear (40mm: 2.58±0.97mg/Mc, 44mm: 14.2±3.57mg/Mc) as expected. Vitamin E liners also showed very low wear (36mm: 20.1±2.00mg/Mc, 40mm: 5.97±0.50mg/Mc). Interestingly however, the CoCr femoral heads also showed measurable wear for all liner types and designs (Conv. 40mm: 0.28±0.16mm^3/Mc, 44mm: 0.22±0.014mm^3/Mc, HXL 40mm: 0.041±0.0060mm^3/Mc, 44mm: 0.21±0.0024mm^3/Mc, Vit-E 36mm: 0.029±0.0097mm^3/Mc, 40mm: 0.064±0.019mm^3/Mc). Heads in a previously reported 44mm metal-on-metal test [1] showed burnishing and scratching (0.22±0.022 mm^3/Mc, liners: 0.16±0.013 mm^3/Mc). The burnishing of the metal femoral heads from all tests (including the MOM test) can be seen in Fig. 1 [Fig. 1 here]. An example showing the circular scratching patterns seen on nearly all femoral heads is shown in Fig. 2, of a 40mm femoral head that was paired with a HXL vitamin E liner [Fig. 2 here].

Our simulator results confirm low wear for HXL UHMWPE acetabular liners both with and without vitamin E. Wear of metal femoral heads, although much less in weight than liner wear, was still clearly detectable and measurable for CoCr heads articulating against all types of UHMWPE liners. Therefore, in wear studies focusing on hard-on-soft material couples such as MOP, the metal head wear should not be ignored.

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Figures

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Figure 3

1A : Kinematics and Wear-knee: #1038 September 21st, 2011, 8:30-9:35

More Than One Type of Vitamin E Stabilized Highly Crosslinked UHMWPE Greatly Reduces Wear in TKA

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The addition of vitamin E has been shown to improve wear performance in highly crosslinked (HXL) ultra high molecular weight polyethylene (UHMWPE) total knee replacements (TKR) [1]. We set-out to verify if a new type of vitamin E stabilized HXL UHMWPE would substantially improve wear performance, and we present our new results together with our previous ones to tell a fuller story. This paper therefore reports in vitro wear of tibial bearings of both conventional and HXL UHMWPE (with vitamin E) for a total of 16 specimens covering both ends of the TKR size spectrum, very large and very small.

Different designs, sizes and four material types/processes of UHMWPE were tested. In material type 1, tested

previously, the polyethylene was machined from isostatic molded GUR1020 bar stock, crosslinked with 10 Mrad, and then doped with vitamin E. From this material, 4 samples of large posterior stabilized (LPS1) TKRs were tested. Material type 2 was HXL where vitamin E was blended into the polyethylene (GUR1020) at the powder stage and the final irradiation was to 9 Mrad. From this material, 2 large cruciate retaining (LCR2) samples and 2 small cruciate retaining (SCR2) samples were tested. The above sample groups from both material types 1 and 2 were compared in the same simulator testing to corresponding identical design, size and sample numbers of conventional UHMWPE not highly crosslinked and with no vitamin E (material types 3 & 4 respectively).

Each test was run on a significantly upgraded (in house) 4-station Instron-Stanmore force-controlled knee simulator. The machine simulated flexion with anatomically realistic joint reaction forces and torques between tibia and femur, and included a spring-based system to simulate soft-tissue restraining forces and torques. The force-control waveforms of the walking cycle specified in ISO-14243-1 were applied for 5 million cycles (Mc) at 1Hz, with bovine serum lubrication with 20g/l protein concentration at 37°C). The tibial bearing inserts were weighed at various intervals standardized between all tests.

No gross delamination or fracture of the tibial inserts was observed in any tests, but all inserts showed measurable wear. The vitamin E stabilized material exhibited an 85% reduction in wear for the LPS1 designs ($p < 0.05$, ANOVA) compared to its corresponding conventional poly control material. The LCR2 and SCR2 designs with the new vitamin E material exhibited wear reductions of 61% and 77%, respectively when compared to their corresponding conventional bearings ($p < 0.05$, ANOVA).

The vitamin E highly crosslinked UHMWPE tibial bearings significantly reduced overall wear when compared to conventional tibial bearings of the same design. Such level of wear reduction should translate to worthy clinical significance in preventing osteolysis. Highly crosslinked UHMWPE stabilized with vitamin E appears to be promising for use as a bearing surface in TKR, from at least two different technologies/processes.

[1] Haider, H., Weisenburger, J.N., Kurtz, S.M., Freedman, J., Schroeder, D.W., Garvin, K.L., "Can Vitamin E Impregnation address concerns of Highly-Cross-Linked UHMWPE in TKR?", Invited podium paper, Proceedings of the 21st Annual Congress of the International Society for Technology in Arthroplasty, Seoul, Korea, October, 2008.

3B : Hip mechanics: #441 September 21st, 2011, 13:50-14:40

Subsidence of the Fully Hydroxyappatite Coated Tapered Collarless Femoral Stem, Initial Radiographic Evaluation.

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Subsidence of the fully hydroxyappatite coated tapered collarless femoral stem, initial radiographic evaluation.

Polawat Witoolkollachit,MD.

The fully hydroxyappatite (HA) coated tapered collarless femoral stem has been available worldwide for more than 20 years. However, in Thailand this design became available in 2007. In uncemented collarless tapered and HA coated designs, axial subsidence is a sign of early failure of the implant. This leads to stem instability, loosening and dislocation. To achieve vertical stability, the surgeon should use the correct surgical technique, accurate instrumentation, appropriate stem size and fill in the femoral canal before biologic fixation occurs. This study addresses the axial subsidence of the design.

Methods

46 consecutive total hip arthroplasties with fully HA coated tapered collarless femoral stem (Corail, DePuy) were performed between July 2007-November 2009 by a single surgeon. Patients with at least 6 months follow-up were included in this study. This involved 39 stems. The average follow-up was 11.86 months (6-24 months). The average age at the time of surgery was 58.6 years (37-83 years)

Results

25 stems (64%) had no evidence of subsidence. 14 stems (36%) had some subsidence. The average axial subsidence was 0.68 mm. The femoral canal shape was identified by canal flare index and classified to stovepipe in 12 cases, normal in 20 cases and Champagne –flute in 7 cases. The average axial subsidences at the end of the

follow-up period were 0.67 mm, 0.8 mm and 0.25 mm respectively. All cases had no signs of loosening. All subsidences occurred on the first 3 months and no further subsidence was detected at 6 months or more. 12 cases (30%) were aged 60 years or older at time of surgery. In this group, 6 cases (50%) had stovepipe femoral stems (canal flare index <3.0).

Conclusion

The fully hydroxyappatite coated tapered femoral stem design shows minimal axial subsidence within the first 3 months after full stability after 6 months.

15B : Bearing materials: #261 September 23rd, 2011, 14:50-15:40

Is Vitamin E Stabilised UHMWPE the Future Material for TKA?

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Is Vitamin E Stabilised UHMWPE the Future Material for TKA?

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Ultra-high molecular weight polyethylene (UHMWPE) has been the gold standard material of choice for the load-bearing articulating surface in knee joint prostheses. However, the application of joint replacements to younger (aged < 64 years) and more active people plus the general increase in life expectancy results in an urgent need for a longer lasting material with better in-use performance.

There are three major material related causes that can lead to joint failure in UHMWPE knee joint replacements: free radical induced chemical degradation; mechanical degradation through wear and delamination; and UHMWPE micron and submicron wear debris induced osteolysis. As a potential solution to these problems, highly crosslinked UHMWPE stabilised with infused antioxidant vitamin E (α-Tocopherol), which is abbreviated as E-Poly, has been of great interest.

In the current work, the wear performance and mechanical properties of Vanguard cruciate retaining (CR) E-Poly tibial inserts were assessed and compared with Vanguard CR Arcom tibial inserts. Also E-Poly plates were compared with direct compression moulded UHMWPE wear plates. Both a multi-directional pin-on-plate tester and a six-station Prosim (Manchester, UK) knee wear simulator were used to assess wear properties of E-Poly plates and E-Poly tibial inserts respectively. All E-Poly plates and tibial inserts were sterilised and vacuum packed in the same way as Vanguard implants before wear testing. The wear knee simulator test was conducted in accordance with ISO 14243-3:2004 with the exception that a more aggressive Tibial Rotation and Anterior/ Posterior displacement profiles, based on the kinematics of the natural knee were incorporated.

Under the same aggressive pre-clinical wear testing condition, compared with Vanguard Arcom CR tibial inserts, Vanguard E-Poly CR tibial inserts experienced an 85% reduction in the mean wear rate. The former had a mean wear rate of 6.51±1.75 mm^3 per million cycles (MC) and the latter had a mean wear rate of 0.96±0.11 mm^3/MC over the 7 million cycle testing period. A similar reduction (80%±8.5) in the mean wear factor was also observed on E-Poly plates compared with a series of direct compression moulded GUR1050 UHMWPE plates processed under a range of manufacturing processing conditions. Wear testing was conducted with a configuration of flat-ended stainless steel indenters multi-directionally sliding against the UHMWPE plates.

Mechanical properties on Vanguard Arcom UHMWPE and E-Polys were evaluated using the small punch test. All tests were carried out using an Instron 5565 Universal Testing System at a constant crosshead speed of 0.5mm/min. With regard to work-to-failure, no statistical difference was observed, with the former being 254.2±4.1 mJ and the latter 255.6±28.2 mJ. However, all E-Polys exhibited strain stiffening due to the stretch of crosslinks. This resulted in a *ca* 12% reduction in elongation to break observed for E-Polys compared with that of Arcom UHMWPE. The former had an elongation to break of 4.1±0.2 mm and the latter of 4.7±0.3 mm.

In conclusion, we have found that Vitamin E Stabilised UHMWPE tibial inserts are promising for knee joint prostheses. However, further investigations are needed to address potential issues such as the particle size and size

distribution of E-Poly wear debris and the associated reactivity.

Biotribology of 40mm Diameter MOTIS PEEK on Ceramic Hip Joints: A Detailed Simulator Study With Different Inclination Angles

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Biotribology of 40mm Diameter MOTIS PEEK on Ceramic Hip Joints: a Detailed Simulator Study with Different Inclination Angles

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Introduction:

Recent concerns over adverse effects of metal ion release, have led to the development of alternative hip joint replacements. This study reports the performance of new hemispherical MOTIS® (milled pitch-carbon fibre reinforced polyetheretherketone) acetabular cups articulating against Biolox Delta® femoral heads with the aim of producing lower wear and more biologically compatible bearings.

Materials and Methods:

The wear performance of 40mm hemispherical MOTIS® cups articulating against Biolox Delta® heads has been investigated. The diametral clearance was 322±15.3nm (mean ± standard deviation). Wear tests were carried out on the Simplified Mark II Durham Hip Wear Simulator to 8 million cycles. New born bovine calf serum was used as the lubricant, diluted to give a protein content of 17g/l. Friction tests were carried out on the unworn joints and worn joints after 7.5 million cycles using lubricants containing protein (bovine serum based carboxymethyl cellulose (CMC) fluids) and without protein (water based CMC fluids). Temperature measured near every hip joint over a continuous wear testing period of 0.5 million cycles was recorded using PICO TC-08 data logger. One K-type thermocouple was placed carefully and consistently in each wear station and two were used to record the ambient room temperature. After stopping the wear test, the data logger continued recording the temperature for a further ten hours to indicate the cooling period. Additionally surface analyses were undertaken before and after wear testing using a non-contacting profilometer and atomic force (AFM) microscope.

Results and Discussion:

Throughout the wear testing, different degrees of fluid absorption were observed for the load control and soak control MOTIS® cups. After normalising the wear data in the post-processing analysis, the corresponding volumetric wear rates, averaged among five worn cups, were 0.551±0.115 $mm^3/10^6$ cycles taking account of the load control and 0.493±0.107 $mm^3/10^6$ cycles taking account of the soak control respectively. In contrast there was no difference in the fluid uptake for the ceramic heads between the load control and soak control. Normalised by the mass changes of the load control, the worn heads produced a volumetric wear rate of 0.243±0.031$mm^3/10^6$ cycles. Interestingly, varying inclination angles had no effects on the wear of ceramic heads and statistically little effects for the MOTIS® cups. The mean lubricant temperature during wear testing varied from 40°C to 45°C with a mean of 43°C. However, friction testing on worn joints produced a mean friction factor of 0.089 which is relatively low for CFR-PEEK bearings. Further investigation is ongoing. Atomic Force Microscopy showed some partial grain pull-out on the ceramic heads.

Compared with the literature, addressing the hard-on-soft hip bearings, the hemispherical MOTIS® cups assessed

in the present study have produced the lowest wear [1-4]. Statistically, high inclination angles appeared to have little effect on the wear performance of the hemispherical MOTIS-PEEK-on-ceramic joints.

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8A : Knee arthroplasty: #1084 September 22nd, 2011, 13:55-14:45

The Road to Stability inTKA

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Presentation September 22

Session 7A

Knee arthroplasty

THE ROAD TO STABILITY IN TKA

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Total knee arthroplasty can be performed with the balanced gap technique with the tibia cut first guided by the use of a tensor. In a case series of 54 cruciate retaining knee implants (Balansys) 150 N tension was applied to distract the extension gap and 100 N to distract the flexion gap.

The following conclusions could be drawn from the collected data:

The varus valgus laxity of the total knee joint measured with stress radiograms in extension was similar to that of the healty subjects with the same age and in flexion one degree more.

The anterior posterior laxity of the total knee joints compared to the healthy knees was on average 1 mm less.

The average ROM of the total knee joints was 118 degrees versus 130 degrees for the healthy knees

Ligament releases did not have a significant influence on the stability of the total knee joints.

The femur rotation guided by the ligament tension in flexion varied from -4 degrees to + 10 degrees referenced from the posterior condylar line. Only knees with a large medial ligament release had on average slighly less external rotation.

Patella position after surgery was not affected by this variable femoral component rotation, only preoperative maltracking was a predictor of postoperative maltracking.

One millimeter distraction of the flexiongap causes 1.9-2.3 mm anterior translation of the tibia indicating that very small gap changes in CR knee can cause a relative large shift of the contact point showing the difficulty to balance the PCL.

In conclusion the balanced gap technique with a tensor system results in very stable total knee implants with good range of motion. This tensor technique in cruciate retaining total knee arthroplasty is safe even when releases are performed. The variable femur rotation did not affect patella tracking.

10A : Navigation: #652 September 22nd, 2011, 16:40-17:30

A Comparison of Computer-Based Anatomic Registration Techniques in TKA: CAS and Customized Instrumentation

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Introduction:

Computer-assisted surgery (CAS) is a tool developed to allow accurate limb and implant alignment in TKA. The strength of the technology is that it allows the surgeon to assess soft tissue balance and ligament laxity in flexion and extension. The accuracy of this ligament balancing technology depends upon an accurate determination of femoral component size. This size is established with intraoperative surface registration techniques. Customized instrumentation (CI) is a measured resection technique in which component size is established on preoperative 3D MRI reconstructions. The purpose of this study is to determine how these two computer-based technologies compare with regard to the accuracy with which femoral component size is established in TKA.

Methods:

67 TKA were performed using CI and 30 TKA were performed using CAS by a single surgeon. CI-predicted and CAS-predicted femoral component size were compared to actual component selection. The process by which CI and CAS perform an anatomic registration was evaluated.

Results:

The CI and CAS systems accurately predicted surgeon-selected femoral component size in 89% and 43% of cases, respectively ($p<0.001$). The discrepancy between predicted and actual femoral component size with CI and CAS was 0.1 and 0.8 sizes, respectively ($p<0.001$). The maximum deviation between predicted and actual femoral component size was greater in CAS than in PMI (three sizes versus one size, respectively).

Discussion:

The CI system was both more accurate and more precise than the CAS navigation system in predicting femoral component size in TKA. CI utilizes preoperative MR imaging to generate femoral component sizing based on optimizing medial-lateral fit with a measured posterior femoral bone resection. CAS utilizes surface registration techniques based on anatomic site registration that may be subject to intraoperative measurement error due to difficult visualization (femoral epicondyles), inherent subjectivity (Whiteside's line) or anatomic variation (hypoplastic posterior condyles). CI bases implant sizing solely on reproducing an anatomical fit and a measured resection technique, whereas CAS attempts to balance an anatomic fit with optimal soft tissue balancing. In this study, the surgeon's final component selection was more likely to be in accordance with the CI rather than the CAS sizing algorithm. This study suggests that intraoperative surface registration may not be as accurate as preoperative 3D MRI reconstructions for establishing optimal femoral component sizing. Surgeons using intraoperative navigation based surface registration need to be aware of this when they are making femoral component size selection, establishing ligament balance, and determining femoral rotation.

5A : Knee mechanics: #654 September 21st, 2011, 16:20-17:10

A Detailed Analysis of the Intra-Operative Accuracy of Custom Instrumentation in Total Knee Arthroplasty

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Introduction:

Custom instrumentation in TKA utilizes pre-operative imaging to generate a customized guide for cutting block placement (Figure 1). The surgeon is able to modify the plan using three-dimensional software (Figure 2). Although this technology is increasingly gaining acceptance, there is a paucity of clinical data supporting it.

Methods:

One hundred and eleven patients underwent primary TKA using the Patient-Specific Instrumentation (PSI) system, in twenty-eight of the cases surgical navigation was used to validate the PSI-generated cuts. Alignment measurements included long-leg alignment and biplanar distal femoral and proximal tibial cuts. Further measurements evaluated femoral implant placement in the AP plane, femoral component rotation, measured bone resection and implant sizing accuracy.

Results:

The mean final limb alignment as recorded by computer-assisted surgical (CAS) tools was 0.3° of varus. Only two limbs were malaligned by greater than 3° (Figure 3). The femoral component had a mean alignment of 0.3° of valgus and 4.5° of flexion (PSI plan 3° flexion). The predicted femoral size was accurate in 89% of cases and the anterior femoral cut was congruent with the anterior cortex in 92% of cases. The PSI-directed femoral component rotation was consistent with the surgeon's perceived rotation in 95% of cases. The posterior condylar bone resection had a mean difference of < 1mm from the predicted resection.

The tibial component had a mean alignment of 0.5° of varus and 8.5° of posterior slope (PSI plan 7° posterior slope). The only statistically significant deviation in alignment was the increased tibial slope (p=0.046) (Figure4). The tibial component size was accurately predicted in 66% of cases.

Discussion:

Custom instrumentation in total knee arthroplasty accurately achieved implant and limb alignment in our study. The plan was more reproducible on the femoral slide. The overestimation of tibial slope and tibial sizing incongruity were related to some of the reference points for the software. A potential benefit of this technology is improved mid-flexion stability by accurately determining femoral component size, placement, and rotation. Further studies are needed to determine the efficiency and cost-effectiveness of this technology.

Figures

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Figure 8

11A : Knee kinematics: #605 September 22nd, 2011, 17:40-18:30

Robust 3D Kinematic Estimation of Total Knee Arthroplasty From X-Ray Fluoroscopic Images

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Purpose:

To achieve 3D kinematic analysis of total knee arthroplasty (TKA), 2D/3D registration techniques, which use X-

ray fluoroscopic images and computer-aided design model of the knee implants, have been applied to clinical cases. In previous feature-based registration methods, only edge contours originated from knee implants are assumed to be extracted from X-ray images before 2D/3D registration. Due to the influence of bone and bone-cement close to knee implants, however, edge detection methods extract unwanted spurious edges and noises in clinical images. Thus, time-consuming and labor-intensive manual operations are often necessary to remove the unwanted edges. It has been a serious problem for clinical applications, and there is a strong demand for development of improved method. The purpose of this study was to develop a pose estimation method to perform accurate 2D/3D registration even if spurious edges and noises exist in knee images.

Methods:

Our 2D/3D registration technique is based on a feature-based algorithm, and contour points from X-ray images are extracted by Gaussian Laplacian filter and zero crossing methods.

The basic principle of the algorithm is that the 3D pose of a model can be determined by projecting rays from contour points in an image back to the X-ray focus and noting that all of these rays are tangential to the model surface. Therefore, 3D poses are estimated by minimizing the sum of Euclidean distances between all projected rays and the model surface. Additionally, we introduce robust statistics into the 3D pose estimation method to perform accurate 2D/3D registration even if spurious edges and noises exist in knee images. The robust estimation method employs weight functions to reduce the influence of spurious edges and noises. The weight functions are defined for each contour point, and optimization is performed after the weight functions are multiplied to a cost function.

Experimental results:

The accuracy and stability validation were performed using in vivo images. The effects of robust estimation were evaluated by comparison with non-robust estimation. One image contained spurious edges and noises, and the other image didn't (they were erased manually). We applied robust and non-robust methods to each image (300 frames). As correct poses, we used the poses which were got by applying previous method to the contour images which spurious edges and noises didn't exist. The root mean square errors (RMSE) and success rate were calculated, and the success rate was defined as the rate of satisfying clinical required accuracy (error is less than 1mm, 1 degree).

As results of the experiments, when non-robust method was applied to contour images in which spurious edges and noises exist, RMSE was too large and success rate was 0 %. However, when robust method was applied to the same images, RMSE was less than 1 mm, 1 degree, and the success rate was about 60 percent. Fig.1 shows typical result of the experiment.

Conclusions:

We have developed a robust 3D kinematic estimation method of TKA from X-ray images, and the method was found to be helpful for analyzing TKA kinematics without labor-intensive operations.

Figures

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Figure 1

3A : Navigation: #1092 September 21st, 2011, 13:50-14:40

Surgical Navigation in Functional ACL Assessment

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INTRODUCTION:

The pivot-shift clinical test is commonly used for the qualitative dynamic evaluation of the translational and rotational knee instability and can be a useful indicator in the prediction of later ostheoarthitis [1]. With the aim of controlling the static antero-posterior knee instability as also tibial subluxation (highlighted with pivot-shift test) many surgeons have started performing anatomical double-bundle (DB) reconstructions, thus trying to reproduce

with the surgery the anatomy and complex functions of the native ACL [1]. In fact the literature suggests that an anatomical DB ACL reconstruction has some biomechanical advantages [2, 3]. Although different studies reported, at a mid term follow up, the superior results of the DB bundle reconstruction with respect to the Lachman's test and pivot-shift phenomenon after, they did not provided quantitative assessment about the global laxity. The objective of this study was thus to quantify intra-operatively the improvements in knee stability and the restore of knee kinematics due to an anatomical DB reconstruction [3] quantifying and correlating static and dynamic clinical tests.

METHODS:

Eighteen patients (32.8±7.6 y) with isolated anterior cruciate ligament injury, that consecutively underwent anatomical DB ACL reconstruction, were included in this preliminary study. Of all patients included in the study, 11 had an abnormal (C) IKDC score and 7 had a severely abnormal (D) score.

To evaluate the joint laxity and kinematics we used an optical navigation system focused in kinematic acquisitions [4]. After tunnel drilling and before graft fixation, the operating surgeon performed manually tests at maximum force: static laxity (antero-posterior (AP), internal-external (IE), varus-valgus) and dynamic laxities (AP and IE decomposition of pivot-shift test) were analyzed before and after graft passage and fixation. Anatomical double-bundle ACL reconstruction was, then, performed [2] and the same kinematic tests were re-acquired. The surgeon was blinded on test results; the whole set of the kinematic data was off-line elaborated. Statistical analysis was performed comparing data derived from stress tests performed before and after reconstruction. For what concerns pivot-shift test in each decomposition we evaluated the areas included by the curves (the 'hysteresis' of the joint due to positive pivot-shift) and the difference in the peaks before and after the surgery at a specific flexion angle. Comparisons between pre- and post-op levels of laxity and of pivot shift were made using paired Student's t-test ($p=0.05$).

In order to verify the sensitivity of the tests, data were also compared grouping patients according to the pre-operative IKDC Knee Examination Form score. The non parametric Mann-Whitney test was utilized for this analysis. Spearman correlation test was used to determine the relationship of the Lachman test and IE rotation at 30° with the laxity peaks achieved during the pivot-shift test.

RESULTS SECTION:

The mean manual maximum AP tibial displacement was 11.9 ± 3.5 mm at 30º of knee flexion and at 9.1 ± 3.3 mm 90º mm before ACL reconstruction, 5.3 ± 1.6 mm at 30º and 4.2 ± 1.3 mm at 90º after reconstruction; the mean manual maximum IE of the tibia was 27.6 ± 4.8º at 30º and 28.3 ± 3.9º at 90º before reconstruction, 21.5 ± 5.8º at 30º and 24.0 ± 4.4º at 90º after reconstruction; the mean manual maximum VV of the tibia was 5.4 ± 1.3º at 0º and 4.4 ± 1.9º at 30º before reconstruction, 3.0 ± 1.1º at 0º and 3.3± 1.1º at 30º after reconstruction.

A statistically significant reduction of the AP displacement, IE and VV rotations was calculated after the ACL reconstruction comparing with the ACL deficient pre-operative condition ($p < 0.05$) in both groups.

Interesting results have been obtained with the analysis of pivot-shift test: coupled peaks in AP translation, at 25.0±1.8º of flexion, are reduced from 11.3±4.7mm to 3.1±3.1mm ($p<0.01$) after reconstruction as also in IE rotation are reduced from 10.8±4.7º to 2.6±4.9º ($p<0.01$) after surgery. The analysis of the area highlighted a huge recovery of the dynamic stability of the joint, from 211.5mm*deg to 57.3mm*deg ($p<0.01$).

There was no correlation between the Lachman test and the peak AP decomposition during pivot-shift test ($r = 0.41$, $p=0.166$); and between IE rotation at 30° and the IE decomposition during the pivot-shift test ($r = 0.21$, $p=0.495$).

Before ACL reconstruction, patients with a severely abnormal (D) IKDC grade had significantly larger areas during the pivot-shift test compared to patients with an abnormal (C) IKDC grade. ($p = 0.002$ for AP area; $p = 0.001$ for IE area). After anatomic double bundle ACL reconstruction, there was no difference in area for those with an abnormal or severely abnormal pre-operative IKDC grade ($p = 0.83$ for AP area; $p = 0.73$ for IE area). There were no significant differences in pre-operative laxity for patients with an abnormal compared to severely abnormal IKDC grade for the Lachman test ($p=0.06$), anterior drawer test ($p=0.30$), VV rotation at 0° ($p=0.84$) and at 30° ($p=0.81$); and IE rotation at 30° ($p=1.00$) and at 90° ($p=0.19$) as well as for the AP peaks ($p= 0.07$) and IE peaks ($p=0.37$) during pivot-shift.

DISCUSSION:

The rationale for anatomic double bundle ACL reconstruction is to restore the structure and function of the native ACL to have a better control not only of antero-posterior knee laxity but also of rotational laxity. This control of

rotatory laxity, often associated with the sensation of "giving way" has been previously studied in *in vivo* and *in vitro* studies, focusing on the quantification of primary or coupled rotational laxities or decomposing complex tests, such as the pivot-shift, in order to find a discriminating parameter for rotational laxity. Previous studies, however, have reported contradictory results. In our opinion a complete evaluation of all knee laxities under different stress, may clarify the contradictory results obtained when analyzing the effects of double bundle ACL reconstruction and, to our knowledge, this evaluation has never been performed before in this type of reconstruction.

The navigation protocol, applied to anatomical DB ACL reconstruction, allowed a quantitative evaluation of knee global kinematics before and after surgery: all ACL-deficient knees showed a positive pivot-shift test before the surgery with huge value in the subluxation of the tibia; anatomical DB seems to eliminate both static anterior/posterior instability (Lachman test) and to control pivot-shift (subluxation of the lateral femoral condyle) reducing tibial translation and controlling tibial rotation.

We found no correlation between the laxity during static tests and the pivot-shift test. This may explain the contradictory results found in literature analyzing rotational laxity with different tests. Primary or coupled static IE rotations may be not sufficient in describing the effect of two grafts in reducing knee laxity.

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5A : Knee mechanics: #1023 September 21st, 2011, 16:20-17:10

Differences in Sizing and Rotational Landmarks of the Distal Femur Between Southern Chinese and Caucasian

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Background:

Recent anthropometric studies have suggested that current design of total knee arthroplasty (TKA) does not cater to racial anthropometric differences. The purpose of this study was to investigate the exact sizing and rotational landmarks of the distal femur collected from a large group of healthy Southern Chinese using three dimensional computer tomographic measurements,and then compare these measurements to the known dimensions from Caucasian populations.

Methods:

This study evaluated distal femoral geometry in 125 healthy Southern Chinese, included 58 women (106 knees) and 67 men (134 knees) with a mean age of 35.2±8.11 years, a mean height of 165.5±7.94 cm, and a mean weight of 61.7±9.56 kg. The width of the articular surface as projected onto the transepicondylar line(ML), anteroposterior dimension (AP), the dimensions from medial/lateral epicondyle to posterior condylar (MEP/LEP)were measured. A characterization of the aspect ratio (ML/AP) was made for distal femur[Fig. 1]. The angles between the tangent line of the posterior condylar surfaces, the Whiteside line, the transepicondylar line, and the trochlear line were measured. The sulcus angle and hip center-femoral shaft angle were also measured. Known dimensions from Caucasian populations were compared with the morphologic data collected in this study[Fig. 2]. In analyzing the data, best-fit lines were calculated with use of least-squares regression. The dimensions are summarized as the mean and standard deviation. The differences of rotational landmarks and sizing between the Southern Chinese and Caucasians were assessed with use of the Student t test. A p value of <0.05 indicated a

significant effect.

Results:

Within the Southern Chineses population, males had larger ML and AP values than females (ML: 70.38±3.09 vs. 62.09±2.52mm, P<0.001; AP: 63.68±2.82 vs. 57.83±2.91mm, P<0.001). The results also showed that Southern Chinese knees were generally smaller than Caucasian (ML: 67.27±4.95 vs. 76.8±7.2mm, P<0.001). The femoral aspect ratio of Southern Chinese was significantly smaller than Caucasian (1.09±0.04 vs. 1.28±0.06, P<0.001). In addition, we found a gradual decrease in the aspect ratio corresponding to an increase in anteroposterior dimension in the distal femur of Southern Chinese, as seen in most other studies. The transepicondylar axis was found to be a reliable landmark to properly rotate the femoral component, so we used the femoral condylar MEP and LEP evaluate posterior condylar offset, the values were respectively 28.62±2.18mm and 22.50±2.19mm. From this study, most of the angles were different from Caucasian. Anteroposterior line minus epicondylar line angle was 90.14±1.30° (Caucasian 90.33±2.44°, P>0.05), anteroposterior line minus posterior condylar line angle was 83.18±1.94° (Caucasian 86.82±2.71°, P<0.001), epicondylar line minus posterior condylar line angle was 7.00±1.70° (Caucasian 3.60±2.02°, P<0.001), trochleoepicondylar angle was 12.45±2.34°(Caucasian 4.95±2.15°, P<0.001), sulcus angle was 147.40±4.69° (Caucasian 139.6±6.96°, P<0.001). The angle between mechanical and anatomic axis of the femur was 5.92±0.47°(Caucasian 6.33±2.42°, P<0.001).

Conclusion:

Because dimensions of the distal femur and the aspect ratio tend to be smaller in Southern Chinese populations, whereas sulcus angles tend to be larger, designs for knee implants should be modified to improve the outcome of surgical treatment in this population. The Larger epicondylar line minus posterior condylar line angles, and the smaller angle between mechanical and anatomic axis seen in Southern Chinese populations also requires us to pay particular attention to surgical technique, in order to ensure patient safety.

Figures

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Figure 4

: #801 , 0:00-0:00

In Vivo Determination of the Cam-Post Engagement in Fixed and Mobile Bearing Tka

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INTRODUCTION:

Posterior stabilized (PS) total knee arthroplasty (TKA) provides posterior stability with the use of a cam-post mechanism which performs the function of the posterior cruciate ligament. The tibial post engages with the femoral cam, prevents the femur from sliding anteriorly and provides the posterior femoral rollback necessary for achieving deep flexion of the knee. However, these designs do not substitute the resection of the anterior cruciate ligament. In order to overcome this deficit, other TKA designs have been recently introduced to provide dual support, with the help of dual cam-post engagement mechanism. Various studies conducted on the PS TKA have suggested that the cam-post mechanism does not engage as designed, resulting in tibial post wear and increased stresses resulting in backside wear of the polyethylene insert component. Also, the in vivo data pertaining to the actual cam-post engagement mechanism in bi-cruciate stabilized knees is still very limited. Therefore, the objective of this study was to determine the cam-post mechanism interaction under in vivo, weight bearing conditions for subjects implanted with either a Rotating Platform (RP) Posterior Stabilized (PS) TKA or a bi-cruciate stabilizing TKA (BCS).

METHODS:

In-vivo, weight-bearing, 3D knee kinematics were determined for eight subjects (9 knees) having a RP-PS TKA (DePuy Inc.) and eight subjects (10 knees) having BCS TKA (Smith&Nephew Inc.), while performing a deep knee bend. 3D kinematics was recreated from the fluoroscopic images using a previously published 3D-to-2D registration technique (Figure 1). Images from full extension to maximum flexion were analyzed at 10° intervals. Once the 3D kinematics of all implant components was recreated, the cam-post mechanism was scrutinized. The distance between the interacting surfaces was monitored throughout the flexion and the predicted contact map was calculated. The instances, when the minimum distance between the cam and post surfaces dropped to zero was considered to indicate the engagement of the mechanism. This analysis was carried out for both the, anterior and posterior cam-post engagement sites.

RESULTS:

The average range-of-motion achieved by the subjects implanted with the RP-PS TKA was 105.9° (SD=13.2°), and subjects with the BCS TKA achieved, on average 126.5° (SD=4.5°) of maximum flexion. During the deep knee bend activity all knees experienced a posterior femoral rollback (PFR) of both condyles.

Anterior Contact (BCS TKA):

Seven of the 10 knees analyzed had the femoral component engaged with the anterior aspect of the tibial post at full extension (Figure 2). However, the contact between them was lost in very early flexion (average: 4.9°; maximum: 9.9°). The contact was always located centrally on the anterior aspect of the tibial post.

Posterior Contact:

The cam-post engaged at 34° for the BCS and at 97° for RP-PS TKA. In the BCS knees, the contact initially occurred on the medial aspect of the tibial post and then gradually moved centrally and superiorly with increasing flexion, while for the RP-PS TKA it was located centrally on the post at all times (Figure 3). Also, there were two subjects in the BCS group who had engagement during mid-flexion (50-90°), but, lost contact with the post between 100-110°, before regaining contact in deeper flexion. One subject in the RP-PS group did not experience cam/post engagement (the minimum distance was 2.2mm at 86° of flexion, which was the maximum for this subject). This could be because the maximum flexion for this patient was less than the average cam-post engagement angle for the RP-PS group subjects

DISCUSSION:

The anterior cam-post interaction in the BCS group was found to be present in a majority of subjects. However, there were three subjects who did not have any contact with the anterior aspect of the tibial post. This can be explained from the fact that the contact point (at full extension) on the medial and lateral side for these three patients was more anterior than any of the other seven subjects analyzed in this study. On the posterior side, contact was established by all subjects analyzed in the BCS group and 8/9 subjects analyzed in the RP-PS group. Also, for the BCS group the initial contact with the tibial post was achieved on the medial aspect, before the contact area tended to move centrally and superiorly with increasing flexion. This could be due to the large amount of lateral PFR combined with lesser amounts of medial PFR (femoral component rotating externally) experienced by the subjects. Therefore, the posterior surface of the tibial post was not parallel to the femoral cam surface. Interestingly, in the RP-PS group, the contact between the cam and post was located centrally on the post at all times when engaged. This is probably due to the mobility of the polyethylene, characteristic for the analyzed TKA design. The polyethylene insert rotated axially in accord with the rotating femur. Therefore the posterior surface of the mobile bearing post was able to remain parallel to the surface of the femoral cam. This phenomenon in the BCS group (Fixed bearing TKA) may increase the chances of edge loading on the polyethylene, resulting in wear patterns on the post.

Figures

: #1116 , 0:00-0:00

In Vivo Analysis of Normal and Implanted Knees: A Comphreshensive Performance Analysis Tool

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No abstract available

POSTERS

Poster: 1
#423

Epidemiological Study of Indications for Simultaneous Bilateral Total Hip Arthroplasty for Osteoarthritis of the Hip

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At our hospital, simultaneous bilateral total hip arthroplasty (THA) is performed employing a direct anterior approach (DAA) in patients with bilateral osteoarthritis of the hip. DAA is advantageous for simultaneous bilateral THA, because it allows total weight-bearing from immediately after surgery without concern over complications such as muscle suture failure, and does not require intraoperative changes in the body position. Also, some patients undergo contralateral THA shortly after unilateral THA, and these patients are considered to have latent indications for simultaneous bilateral THA. In this study, we investigated the frequency of such indications encountered in general clinical practice.

Of the patients who underwent initial THA at our hospital between April 2008 and March 2009, 231 patients with 291 hips preoperatively diagnosed as osteoarthritis were evaluated. The initial surgery was simultaneous bilateral THA in 52 hips (18%) and unilateral THA in 239 hips (82%). In those who underwent unilateral THA, contralateral THA was performed within 1 year before or after this surgery in 36 hips (12%) and 1 year or more after this surgery in 32 hips (11%).

The period of postoperative rehabilitation is shorter, and patients can return to social activities earlier, after simultaneous bilateral THA than after two-stage bilateral THA. Furthermore, the procedure has also become safer recently and has a medicoeconomic advantage. In this study, THA was simultaneous bilateral in 18% and two-stage with an interval of within 1 year in 12%. Since about 30% of all patients with osteoarthritis of the hip encountered clinically in Japan show indications for simultaneous bilateral THA, the frequency of the procedure is expected to increase further.

Poster: 2
#486

Relationship Between Intraoperative Gap Measurement and Prosthesis Selection in Total Knee Arthroplasty for Flexion Contractured Knee.

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It is well known that PCL resection makes flexion gap (FG) larger than extension gap (EG) and that in flexion

contractured knees, EG is usually smaller than the FG. However, the PS implant is often used in flexion contractured knees. To make equal gap space in extension and flexion, selection of the PS implant can be disadvantagous. To investigate the relationship between flexion contracture and the gap situation, we measured EG and FG before resectioning the PCL intraoperatively.

Of the patients who underwent initial TKA at our hospital between July 2010 and January 2011, 36 knees with flexion contracture of more than 10 degree were evaluated. The patients were aged 40-86 years (mean of 71years) and consisted of 6 men and 30 women. We excluded patients with a ruptured or macroscopically insufficient PCL. EG was made by standard resection of distal femur and proximal tibia. FG was made 4 mm smaller than the usual resection by pre-cutting of the posterior femoral condyles. Rotation of the pre-cut line was initially decided by anatomical landmarks. All osteophytes were removed and soft tissue release was performed if necessary. After checking EG, FG, and ligament balance, if FG was large enough to conserve the PCL, the CR implant was selected. If not, the PS implant was selected.

Flexion contracture was divided into 3 groups. 10-19 degrees, group 1. 20-29 degrees, group 2 and more than 30 degrees, group 3. 21 knees (mean of 13 degrees) were involved in group 1, 9 knees (mean of 22 degrees) in group 2, and 6 knees (mean of 38 degrees) in group 3. After pre-cutting, EG and FG (corrected by amount of pre-cut) was 16.4mm/18.5mm, 15.4mm/19.6mm, 10.3mm/18.7mm in group 1, 2, and 3 respectively. EG became smaller as flexion contracture grew larger. The CR implant was used in 13 knees and PS implant in 8 knees in group 1, CR in 8 knees and PS in 1 knee in group 2, and CR in 5 knees and PS in 1 knee in group 3. In almost all cases the CR was implanted without difficulties.

Perhaps some surgeons feel that the PS component is preferable in flexion contractured knees, because it is easy to manage during surgery. However, the primary purpose of TKA is to make adequate extension and flexion gaps. Selection of the PS component in flexion contractured knees can result in inadequate gaps. To make adequate extension and flexion gaps, intraoperative measurement and appropriate selection of component is mandatory.

Poster: 3
#495

A Novel Design Concept for a Total Knee Replacement With Condylar Guiding Features

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INTRODUCTION:

The differences in the functional outcomes of the subjects with normal knees and those who have undergone TKR may be related to different kinematics between the normal and the artificial knees. In this study a novel design concept for a TKR with normal kinematics was introduced and tested. The novelty of the design is in the shapes of the lateral bearing surfaces that can actively control the axial rotation of the joint in both directions during extension and flexion. To test the viability of the design, prototypes of the components with the suggested shapes were made and their kinematics under the effect of compressive loads was tested.

METHODS:

The shape of the lateral bearing surface of the femur was defined by a series of 2D curves on the frontal plane at equal intervals of flexion angle from 0° to 150°. In the design of the lateral condyle, the bearing spacing between the condyles was assumed constant, and the shapes of the lateral contact curve was composed of two circular tangent arcs on the medial and lateral sides of the contact point, radii of which varied in opposite directions by increase and decrease of flexion. The shape of the matching tibial bearing surface was formed by incorporating variations in the shape of the lateral condyle similar to the femoral component (Figure 1). The passive kinematics of a cadaver knee, after being processed to meet the required kinematics characteristics for this particular design, was used as input for generating the shapes of the bearing surfaces.

Rapid prototypes of the components were made from ABS material and put on an AMTI knee simulator equipped with an additional module that allowed for free motion and rotation of the tibial component in response to the guiding effect of the articular surfaces (Figure 2). Optotrak motion tracking LEDs were attached to the components, and compressive forces of 80lb, 115lb, and 160lb were applied on the joint.

RESULTS:

Figure 3 shows the relative motion of the femur with respect to the tibia for the tested range of motion. The results showed that the prototype generated a motion pattern very close to what was used as input for the design. The centre of the medial ball-and-socket and the lateral epicondyle showed translations and rotations of 0.9mm and 21° in comparison to 0mm and 22° values of the input kinematics.

DISCUSSION:

The results of the tests validated the viability of the concept and methodologies for design of a surface guided knee. A design that can replicate the passive motion of the joint and the neutral path of motion around it can, in theory, generate normal kinematics in activities. The generated motion matched the kinematics observed for an unloaded knee joint. Appropriate laxities around the observed path can be obtained by adding adequate clearances to these bearing surfaces. The concept, design features, and methodologies developed in this study can potentially be used as the foundation for development of a new type of TKR with more normal kinematics.

Figures

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Figure 1 HYPERLINK "http://app.istaonline.org/figures/466.jpg" \t "_blank"
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Figure 3

Poster: 4
#501

Tribological Evaluation of Tissue Engineered Cartilage Using MPC-Polymer Grafted Surface.

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Introduction

It is important to examine the tribological maturation of regenerated cartilage for planning the after-treatment. However observation and evaluation method for the surface gel-hydration lubrication have not been established yet and function of the superficial layer of the cartilage has not been clarified yet. In this experiment, MPC-polymer (poly[2-(methacryloyloxy)ethyl phosphorylcholine]) brushes grafted surface was used as a counter face of frictional testing to measure the hydration lubrication The MPC-polymer is a phospholipid analogue hydrophilic polymer and can strongly attract water molecules without disturbing the hydrogen bonding of free water. Thus, the attracted water molecules are able to rapidly exchange with each other, and therefore the free water may be able to keep low friction supporting the applied load. Our experiments have done on the assumption that the hydration lubrication of the regenerated cartilage can be measured by using the MPC-polymer grafted surface as a counter face of the frictional testing.

Materials and Methods

The MPC-polymer grafted surface was prepared by atom transfer radical polymerization (ATRP) which was carried out for 3 hours after treating silicon surface with 3-(2-bromoisobutyryl)propyl dimethylchlorosilane (BDCS) to form a monolayer that acts as initiators for the ATRP. Articular cartilage specimens were obtained from porcine condoyle of femur (180~190 days old) and cut into 5 mm diameter plugs. The regenerated cartilage was prepared by seeding chondrocytes onto fibroin scaffold and cultured with DMEM containing 10 vol% FBS, 1 vol% antibiotic and 0.2 mM ascorbic acid (A8960, Sigma-Aldrich Co., Japan) at 37°C in a humidified atmosphere of 95% air and 5% CO2. The culture periods were 7days and 14days. Friction test was carried out by reciprocating friction apparatus using saline solution as the lubricant. The applied normal load was 300 N (about 0.15 MPa), and the sliding velocity was 0.008 ~ 4.000 mm/s. The load was applied for 600 seconds before the sliding began.

Results and Discussion

The results showed that the friction coefficient of normal cartilage surface against the MPC surface was about 0.052, which is near to the value of normal cartilage surfaces, and friction coefficient of regenerated cartilage was about 0.11, while friction coefficient increased significantly to about 0.27 between control and MPC surface. The normal cartilage maintained the low friction even at low sliding velocity (0.008 mm/s) and the friction coefficient increased with sliding velocity. The friction coefficient of regenerated cartilage showed the same tendency as normal cartilage but it was a little higher than normal cartilage. The difference between culture periods was not observed (Fig. 1). These results show that lubricating function cannot be totally matured for 14 days.

Figures

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Figure 1

Poster: 5
#687

Virtual Planning and Computer-Aided Hip Arthroscopy: Obstacles and Preliminary Results

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Theoretical models have shown that the range of motion is impaired in patients with femoroacetabular impingement and that the acetabular cartilage is at risk of being damaged as a result of abnormal shear stresses even with normal activities of daily living. Computer-aided technologies might add to the early diagnosis and adequate treatment of those lesions.

Computational tools for three-dimensional analysis of femur head sphericity and hip range of motion evaluation were developed. These tools allow for virtual planning of the osteochondroplasty in femoroacetabular impingement. The virtual plan was used for computer-assisted navigation in hip arthroscopy. Both image-free and imaged-based protocols were evaluated using the Stryker Orthomap 3D navigation and planning software (Stryker, Mahwah, NJ, USA). In case of the image-based protocol, inta-operative matching of the patient anatomy was obtained using the Ziehm Vison 3D fluoroscope (Zhiem, Nürnberg, Germany). (Fig 1)

Both methods were found to have their own specific advantages and disadvantages that need to be addressed before more intensive use of these technologies can be considered. We present our preliminary findings using both techniques, as well as the surgical and technical obstacles that need to be dealt with in the future.

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Figures

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Figure 1

Poster: 6
#943

Biocompatibility of an Electroconductive Silk Fibroin Nanofiber Scaffold With in Vitro Cultures of Human Mesenchymal Stem Cells and Dermal Fibroblasts.

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Introduction:

The possibilities of scaffolds composed of nanofibers of silk fibroin (SF) could be greatly enhanced by conferring them electroconductive functionalities. Here we will present the method for making a hybrid material made of SF coated with polypyrrole (PPy-SF), studying its biocompatibility as scaffold for proliferation of primary human mesenchymal stem cells (MSCs) and human dermal fibroblasts (hFb)

Methods:

The silk fibroin meshes were obtained by electrospinning of a 17% (w/v) SF solution (in HFIP). After the annealing with methanol they were coated with polypyrrole.

Physical, structural and mechanical properties were characterized using SEM, FTIR spectroscopy, and a mechanical tester. Electrochemical experiments were also performed.

MSCs were obtained by direct aspiration of ileac crest from volunteer donors. The cells were isolated by gradient ficoll using a SEPAX™ System device and cultivated.

Human dermal fibroblasts where obtained from a skin biopsy that was washed several times in PBS (containing 100 U mL-1 penicillin and 100 μg mL-1 streptomicin). Subcutaneous tissue was separated from the skin and cut into small pieces (1-2 mm) that were placed in 6-well plate and stuck with a solution of 0.1 % w/v collagenase in DMEM for 1 h, at 37 ºC, 7,5% CO2.

In both cases the culture medium used was DMEM supplemented with 10% FBS and routine antibiotics (100 μg/mL-1 streptomycin and 100 U/mL-1 penicillin). When the cell confluence reached 80% the cells were re-plated in 75 cm2 flask.

Pieces of mats were seeded (20.000 cells/cm^2) into 24 wells cell culture plates and proliferation was measured by MTT staining at 1, 7, 14 and 21 days.

Results:

The average diameter of SF-PPY coated fibers was 2630 nm (ranging from 472 to 8670 nm).

FTIR spectroscopy indicates that the conjugated polymer has some interactions with the peptide linkage affecting to SF macromolecular chains

Cells showed an excellent adhesion on the materials tested just 72h after the seeding and a slight growing tendency was observed.[Fig. 1]

Conclusions:

Our results show the ability of electrospun silk matrices to support MSCs and hFb attachment, spreading and growth in vitro. We add a new point of view, using conducting polymers (PPY) adsorbed to SF fibers in order to increase the electric conductivity of the mats with its possible additional benefits due to the relevance of electric fields in bone cell function and neural tissue applications.

Acknowledgements:

This research was partially funded by INIA

Figures

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Figure 2

Poster: 7
#561

Early Outcomes of a Unique ACL Substituting Total Knee Design in a Non-Designing Srugeon, Multicenter Study

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Introduction

Total knee prosthetic design continues to be a controversial topic in arthroplasty surgery. Many studies have failed to show clinically significant differences in prosthesis design and have been limited to small series, often confined to designing surgeons. We undertook a multicenter, prospective, non-designing surgeon, study of a unique total knee prosthetic design to determine early functional outcomes. The 3DKnee™ design studied uses a novel ACL substituting, lateral pivoting design intended to better reproduce normal knee kinematics. Because of its unique conforming bearing surface, this prosthesis has been employed in both posterior cruciate retaining and posterior cruciate sacrificing techniques.

Methods

One hundred and twenty-eight patients were entered prospectively at eight joint centers according to strict criteria. Forty- three patients completed their one year follow-up. Approval was obtained from the appropriate IRB at each center. The mean age of the subjects was 67 years. Women represented 62% and men, 38% of the study participants. The average body mass index for the subject was 32 lb/in^2. All patients received a 3DKnee™ prosthesis (DJO Surgical, Austin TX). Forty-seven per cent of the studied patients had their posterior cruciate ligaments retained. The rest (53%) had their prostheses inserted with sacrifice of the PCL. All patients were followed with preop, postop, 6 month, and yearly evaluations. Instruments included the Oxford Knee Score, WOMAC, Knee Society Pain and Functional Scores. Standardized radiographic evaluation was completed at each follow up visit. A simple satisfaction survey was also administered.

The mean preoperative Knee Society Score was 45.4 and the mean Knee Society Functional Score was 50.9. The mean preoperative WOMAC was 50.0. Preoperatively, the mean Oxford Knee Score was 20.0. Data were statistically analyzed using the Wilcoxen ranked-signed test.

Results

At minimum one year follow up, the mean Knee Society Knee Score was 80 (range 22 to 100). The mean Knee Society functional score was 78 (range 26 to 100) Mean range of motion was 2 to 115 degrees. Mean WOMAC had improved to 91 and the mean Oxford Knee Score was 41. There were no intraoperative complications such as fracture or conversion to a different prosthetic design. Four patients required a manipulation under anesthesia. There was one early wound dehiscence and one ruptured PCL that required a return to the OR. There were no fractures, thromboembolic events or other major complications in this group. There was no loss of radiographic alignment or signs of loosening on the most recent radiographs. Eight six percent of patients reported good to excellent pain relief and 92% felt that they had achieved a good to excellent result.

Conclusion

The 3DKnee™ prosthesis demonstrated excellent early results in a wide variety of patients entered into a multicenter study, which excluded the designing surgeon. The unique conforming design allowed retention or sacrifice of the PCL with equal function results and equal relief of pain. Continued follow-up is required to verify the long-term durability of the excellent early results demonstrated by this prosthesis.

Poster: 8
#999

Mid-Term Results of the Internal Proximal Femoral Replacement in Hip Revision Arthroplasty

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Introduction

Loss of proximal femoral bone stock due to tumour or previous arthroplasty surgery poses a reconstructive challenge. A custom-made 'internal proximal femoral replacement' prosthesis manufactured by Stanmore Implants Worldwide was designed to address these issues. This implant allows cemented distal fixation, retaining the abductors and the remaining proximal femoral bone stock. The proximal shell of bone is wrapped around a hydroxyapatite coated proximal stem to encourage osseointegration and secured with cables. The indications for prosthesis implantation include Paprosky grade IIIB and IV defects and infection or difficult peri-prosthetic fractures with proximal bone loss.

Objectives

The objectives were to examine the outcomes of patients who underwent internal proximal femoral replacement at our institution.

Methods

Between 1995 and 2010, 77 internal proximal femoral replacements were implanted in 76 patients with a mean age of 67.8 (36 to 90) years. The mean number of previous operations on the hip was 2.2 (1 to 7). The indications for surgery were aseptic loosening in 42 patients, peri-prosthetic fracture in 14 patients, infection in 9 patients, aseptic loosening and peri-prosthetic fracture in 9 patients, non-union in 2 patients and a fractured prosthesis in 1 patient. Patients were followed-up in clinic, where a note of all complications was made. At final follow-up, patients were assessed using the Oxford Hip Score.

Results

Complications occurred in 21 patients (27.6%). There were eight dislocations, seven new infections; one case was infected previously and treated with a two-stage revision and therefore was not counted as a new infection, two cases of aseptic loosening, two peri-prosthetic fractures and in two cases the prosthesis fractured. Other complications included one haematoma requiring evacuation. Infection was successfully eradicated in two patients with antibiotics and washout. Four patients have a chronically infected prosthesis, controlled with long-term oral antibiotics. (See Figure 1)

Nine (11.8%) patients underwent revision surgery at an average of 29.3 (3 to 113.6) months; four for recurrent dislocation, one for an acetabular fracture secondary to dislocation, one for infection, one for a peri-prosthetic fracture and two for fractured prostheses. Two patients are awaiting revision, one for aseptic loosening and one for recurrent dislocation. (see Figure 2)

Fifteen patients died and two emigrated so were lost to follow-up. Fifty-nine patients were reviewed after a mean of 68.5 months after surgery (13.2 to 190.6). The mean Oxford Hip Score was 32.8 (7 to 48). On further questioning, 49 patients (83.1%) were satisfied that the operation had improved their quality of life compared with preoperatively.

Conclusions

When there is severe loss of femoral bone stock either due to tumour or previous revision hip arthroplasty, the surgical options are limited. This technique allows instant distal fixation while promoting biological integration and restoration of bone stock. The mid-term results are encouraging, demonstrating good functional results with a comparable complication rate.

Figures

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Figure 2

Poster: 9

#988

Atypical Pseudotumour After Metal-on-Polyethylene Total Hip Replacement Causing Deep Venous Thrombosis

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A 71 year old lady underwent a left metal-on-polyethylene total hip arthroplasty (THA) and presented five years later with a painful left groin mass and reduced walking distance. Examination revealed a 20% increase in left thigh girth. A firm left inguinal mass was palpable just above the inguinal ligament, fixed to the underlying structures. The patient had excellent range of movement.

Plain radiographs depicted well seated implants with no evidence of loosening or heterotopic ossification (Fig 1).Inflammatory markers were normal and white cell scan unremarkable. A magnetic resonance imaging (MRI) scan revealed an enlarged left-sided mass surrounding and involving the iliopsoas tendon measuring 4.3cm x 5.2cm (Figure 2). This was compressing the common femoral vein, which was thrombosed. Core needle biopsy revealed necrotic tissue with macrophage and lymphocytic infiltrate. A caval filter was inserted and the patient commenced on warfarin.

A revision THA was undertaken. A large volume of yellow-grey dense inflammatory tissue was noted extending anteriorly into the hip joint, surrounding the acetabular cup. There was no evidence of loosening with minimal volumetric wear noted in the polyethylene liner. The visible parts of the mass were excised through a combined anterior and posterior approach, the cup was exchanged and bearing surfaces revised to ceramic-on-ceramic. The original femoral stem was left in situ. Histology revealed extensive fibrinoid necrosis surrounded by a mixed chronic inflammatory cell infiltrate comprising predominantly lymphocytes and histiocytes with some plasma cells and granulomas. Occasional vessels with mural inflammation were noted with perivascular lymphocyte cuffing. There were no acute inflammatory cells and no pigment-laden macrophages.

Warfarin was continued for 6 months until repeat MRI scan confirmed a patent common femoral vein with no evidence of deep venous thrombosis (DVT) (Figure 3). At 9 month follow-up, the patient was asymptomatic.

The development of pseudotumours after THA can lead to catastrophic consequences necessitating early revision. Pseudotumours have long been associated with conventional metal-on-polyethylene bearing hip arthroplasties due to wear debris. Such lesions are characterised histologically by polyethylene-laden macrophages, giant cells and foam cells. More recently, there has been increased interest in pseudotumour formation following metal-on-metal bearing failure. Common histological features include macrophage and lymphocyte infiltration around small vessels with extensive necrosis. This variation of a type IV delayed hypersensitivity is termed an aseptic lymphocyte-dominated vasculitis- associated lesion (ALVAL).Our case is unusual in that the pseudotumour had histological appearances in keeping with a metal-on-metal failure.

This is also the fourth reported case of a pseudotumour causing a DVT and stresses the fatal consequences that can ensue. There was a delay in diagnosis of our case; an increased awareness of pseudotumour occurrence following arthroplasty should alert the physician to patients presenting with abdominal pain, masses, and urological or neurovascular signs and symptoms. CT and MRI are invaluable in visualising the mass whilst arthrography can outline the relationship to the hip and prosthesis. Revision of the components to ceramic on ceramic bearing surfaces seemed to remove the source of the problem and the pseudotumour was seen to be fibrosed on MRI six months later causing no symptoms.

Figures

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Figure 3

Poster: 10
#1000

Limb Reconstruction in Skeletally Mature Patients Using Non-Invasive Extendible Endoprostheses.

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Introduction

The Stanmore non-invasive extendible endoprosthesis was initially developed for lower limb reconstruction following bone tumour resection in skeletally immature patients. The components include a magnetic disc, gearbox and drive screw to allow gradual, painless, controlled extension to be undertaken in clinic after surgery via electromagnetic induction. This prosthesis has since been adapted for use in adults undergoing revision for failed joint replacement with existing limb-length inequality. In these cases, the extendible endoprostheses allow joint reconstruction or facilitate an arthrodesis whilst replacing bony defects and allowing non-invasive restoration of limb length postoperatively.

Objectives

The objectives were to examine the outcomes of skeletally mature patients who underwent reconstruction with the Stanmore non-invasive extendible endoprosthesis for failed joint replacement with limb-length inequality after malignant or non-malignant disease.

Methods

Between 2003 and 2010, eight distal, six proximal and two total femoral endoprostheses were implanted in sixteen adults with a mean age of 43.4 years (18-73).In eight patients, the initial reconstruction had been performed for neoplastic disease and in eight for non-neoplastic disease (trauma or osteoarthritis). Patients had previously undergone a mean of four (2 to 9) open procedures on the affected limb before revision with the non-invasive extendible endoprosthesis. Patients were assessed using the Musculoskeletal Tumour Society Score (MSTS) and the Toronto Extremity Salvage Score (TESS). At each clinic appointment, a note of all complications was made.

Results

Fifteen endoprostheses were lengthened in clinic without anaesthesia using the principle of electromagnetic induction. One patient did not need lengthening due to equal leg lengths postoperatively. The mean length gained was 49.6mm (10 to 107) requiring a mean of eight (1 to 23) lengthening episodes. One patient died six months after surgery from natural causes. There were six cases of infection postoperatively; four of these occurred after revision of a previously infected implant. Infection was the only complication noted in this study. Three patients subsequently underwent revision to a non-extendible endoprosthesis, one patient underwent an amputation and another patient a conversion to amputation prosthesis. One patient was treated with washout and intravenous antibiotics. Planned exchange of the prosthesis was necessary in two patients after attainment of the maximum lengthening capacity of the implant. There was no failure of the lengthening mechanism. At most recent follow-

up of the eleven patients with the non-invasive extendible implant still *in situ*, the mean Musculoskeletal Tumour Society score was 75.7% and the Toronto Extremity Salvage Score was 78.1%.

Conclusion

Non-invasive extendible endoprostheses can provide patients with good functional results and restoration of leg-length equality whilst avoiding open lengthening procedures. However eradicating pre-existing deep infections remains a significant challenge. The application of silver-coated technology to extendible implants may help reduce morbidity and further improve outcomes

Poster: 11
#720

Are ORIF Limits of Complex Calcaneus Fractures With Locked Screws Calcaneus Plates Driven Back?

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INTRODUCTION:

Internal Fixation of complex calcaneus articular fractures is debated: a perfect and upheld reduction is challenging. Could locked screws calcaneus plates drive back the limits of Internal Fixation instead of initial arthrodesis, involve a faster rehabilitation and improve the results?

METHODS:

Between 2004 and 2008, 32 patients (26 men, 6 women), sustained 35 complex calcaneus articular fractures. Age: 41.46 [17-71] ±15.99 years. Pre-operative CT scans: 3 and 4 displaced articular fragments (Sanders III: 22 and Sanders IV: 13). ORIF by the same surgeon, between D 4 and D 7, through a lateral approach and using an AO LCP® locked screws calcaneus plate. Intra operative X-ray controls, postoperative CT scans. Articular re-habilitation after D 30. Complete weight bearing after D 90. Follow-up until 60 months (X-ray and Kitaoka score).

RESULTS:

Obtained and upheld anatomical articular reduction –i.e. Boehler's angle, talo and cubo-calcaneal congruence-: 35/35. Bone healing after 8 weeks: 21/35 and after 12 weeks: 14/35. Delayed wound healing -smokers-: 6/35. Anatomical articular upholding after 12 months: 35/35. Plate ruptures at D 90 without displacement: 2/35. Walking without crutch after D 90: 35/35. Mean follow up: 50 months.

DISCUSSION AND CONCLUSIONS:

Locked screws calcaneus plate used for the fixation of complex articular calcaneus fractures showed no displacement in the primary and secondary healing time. These facts limit the place of initial arthrodesis and streamline the initial recovery process. This may be beneficial for clinical use and the long term follow-up.

Figures

Poster: 12
#920

A Prospective Observational Study of Displaced Femoral Neck Fractures Treated With a Cushion Bearing Acetabular Component

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Introduction: Treatment of femoral neck fractures in physically active elderly patients is still an open question. The comparison of total hip replacement and partial hip replacement showed substantial superiority of the first approach. However we cannot disregard the problems associated with THR in the elderly: longer surgical time, greater blood loss, major sacrifice of bone in osteoporotic subjects. The Tribofit® Acetabular Buffer has the objective to address these problems with the implantation of a single 3mm soft, pliable buffer made of polycarbonate-urethane between the large diameter metal femoral head and the subchondral bone, thus replacing the articular cartilage. The surgical technique includes the reaming of the cartilage layer, the creation of an

equatorial groove and a snap-fit insertion of the buffer.

The purpose of this prospective study is to evaluate the effectiveness of this device in the treatment of femoral neck fractures in the elderly.

Materials and Methods:

From September 2008 to July 2010 we performed 45 implants using the Tribofit® Acetabular Buffer (Active Implants Corporation, Memphis TN, USA). The criteria for inclusion in the study were: femoral neck fracture in patients over 75 years of age, physical independent before the fracture, with good expectations of longevity, mild or absent arthritis, absence of morphological alterations in the acetabulum. The average age of these patients was 81,2 (range: 75-89), the sex distribution was 36 females and 9 males, with 22 fractures of the left hip and 23 of the right. In all cases a cementless straight femoral stem was implanted.

We recorded per-operative blood loss and intra-per-operative problems encountered. Controls were performed in the first, third, sixth and twelfth month post-op by radiography and clinical examination. The clinical outcome was objectively by the tests HHS, VAS and SF-36.

Results:

Of the 45 patients, 4 died of unrelated causes and 3 were lost to follow-up (2 due to cognitive impairment and 1 due to peri-prosthetic femoral fracture). Of the 38 available for follow-up, all were followed at the staged time. The average follow-up period is 21.2 months (range: 11-33). No intra-operative problems were recorded. The mean HHS score for these patients was 74,2 at 6 and 86 at 12 months. The mean VAS was 4,3 at 6 and 2 at 12 months. The mean SF-36 Score for these fractures patients was 57,3 at 6 and 53,2 at 12 months. We had 2 dislocations in the third post-surgical week while the two patients were in a rehabilitation centre. Open reduction was carried out and in both cases the buffer was not mobilised.

Discussion and conclusions:

We believe the results with this new type of prosthesis are encouraging and comparable to if not better than other prosthetic options in the literature for this difficult-to-treat patient population.

Poster: 13
#417

The Use of Burch-Schneider Anti-Protrusio Cage in Revision Surgery of Total Hip Arthroplasty

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INTRODUCTION

Severe loss of acetabular bone stock in Total Hip Arthroplasty (THA), due to polyethylene debris, to the motion of the loosened socket and to the natural history of the original disease, constitutes a challenge in revision surgery of THA.

MATERIALS AND METHODS

From 1996 to 2006, we performed 48 revisions using the Burch-Schneider Anti-Protrusio Cage (B-S APC) in 43 patients with severe acetabular bone loss. All the patients received an antero-lateral approach; Homologous bone graft was used to fill any bony defects. We assessed radiologically the bony defect (according to the AAOS classification) and the changes of the center of rotation of the hip pre and postoperatively; we also assessed the Harris Hip Score.

RESULTS

Fourteen patients had an acetabular defect type 1; eleven type 2; fifteen type 3; seven type 4 and one type 5. The Preoperative Harris hip score average was poor (59.07); at latest follow-up, an average value of 85.5 points (range, 70-97 points) was obtained. 2 patients developed deep infection needing a revision and 2 result in a poor fixation. The mean difference of the center of rotation pre and post-operatory was 1,5 cm (range 4-0,3 cm)

DISCUSSION AND CONCLUSION

Extensive acetabular deficiency represents a challenge in revision surgery of the hip. The use of a B-S APC fixed with screws to the iliac bone ensure a primary stability of the cage. Filling the bony defect with homologous bone graft permit a recovery of the bone stock. A cemented insert allows a result very close to a primary surgery.

Poster: 14
#897

Analysis of Failed Van Straten LPM Proximal Interphalangeal Prostheses

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Introduction

Finger arthroplasty lacks the success seen with hip and knee joint replacements. The Van Straten Leuwen Poeschmann Metal (LPM) prosthesis was intended for the proximal interphalangeal (PIP) joints. However revision rates of 29% after 19 months were reported alongside massive osteolysis.

There are no reports in the literature of ex vivo analysis of such failed devices.

Methods and Materials

Three failed LPM titanium niobium (TiNb) coated cobalt chrome (CoCr) components were obtained following revision surgery- two distal and one proximal.

All three components were analysed using an environmental scanning electron microscope (ESEM). This gave the chemical composition of the surface to determine if the TiNb surface coating was still intact. The distal components were analysed using a ZYGO non-contact profilometer (1nm resolution) with the proximal component unable to be analysed due to its shape. ZYGO analysis gave the roughness average (Ra) of the surface and determined the presence of scratches, pitting and other damage. The proximal component was subjected to a nanoindentation test to determine the hardness and Young's modulus of the coating and substrate.

Results and Discussion

Images obtained from both the ZYGO and the ESEM indicated that the surfaces of all components were heavily worn. On the articulating surfaces of both distal components unidirectional scratching was dominant, while the non-articulating surface showed multidirectional scratching. The presence of unidirectional scratching suggested two-body wear, whilst the multidirectional scratching on the non-articulating surface of the distal component suggested that trapped debris may have caused three-body wear. The small distal component was more heavily worn than the larger distal component which was reflected in the Ra values.

The average Ra for the large distal component was identical for the non-articulating and articulating surfaces at 0.157μm. For the small distal component the articulating surface Ra average was 0.257μm compared with the non-articulating surface average of 0.298μm.

The ESEM chemical analysis showed that in some regions on the distal component the TiNb coating had been removed completely and in other areas it had been scratched or penetrated. On the proximal component the TiNb coating had been almost completely removed from the articulating surfaces and was only present in small amounts on the non-articulating surfaces. There was little evidence of bone attachment to the titanium coating which was intended to help provide fixation.

ESEM images showed the TiNb coating had been removed in some sections where there was minimal scratching, suggesting this scratching did not impact significantly in the coating removal. Therefore here the main cause of coating removal may have been corrosion at the interface layer between the coating and substrate, although scratching may have also have played a part.

The osteolysis reported clinically may have been linked to the wear debris from the failed coating.

Poster: 15
#665

Questioning Tibial Cut First for Sound Biomechanics in Total Knee Replacement: Femur First and .. Custom Made Femoral Implant

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Questioning tibial cut first for sound biomechanics in total knee replacement: femur first and .. custom made femoral implant

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Many studies have been performed on the biomechanics of total knee replacement and insist on neutral alignment and perpendicular joint line in extension. In flexion, the opinions are quite different between reference to the transepicondylar axis (with independent cuts) or balanced flexion gap (dependent cuts).

These two approaches favor either sound tibiofemoral mechanics around the transepicondylar axis or stability in flexion but with non coincidence of the prosthetic centers of rotation.

When performing total knee replacement besides soft tissues, two factors must be first approached: joint line orientation in relation to mechanical axis and extraarticular deformity in the coronal plane.
Surgeons must understand the consequences of changing the orientation of the joint line especially in flexion and on the patella.

When there is an extraarticular deformity, should it be preserved and described as natural alignment or corrected outside of the joint or corrected by intraarticular releases with consequences for the mechanics of the knee joint.

Total knee surgeons are describing the discomforts after total knee replacement such as not forgotten joint (but some are!), anterior knee pain, lack of flexion and abnormal laxities.

When studying the changes of the shape and position of the femoral component between anatomical & prosthetic, these complaints are not surprising.
In normal knees, the articular surface is special to eachindividual. But more, as sport medicine doctors, we know that the soft tissues are also specific to each individual and fit with the bony anatomy. So, not only the articular surfaces but also the collateral ligaments, the cruciate ligaments are dictating the biomechanics of each knee.

Today there is a trend to use custom femoral cutting guides. This should allow the surgeons to fit exactly the femoral extremity at its original surface and to use in harmony the soft tissue to regain the normal physiological mechanics of this knee. Then with the knowledge of the original shape of the tibia and with special adjusting tibial cutting blocks, we should be able to reconstruct the original mechanics.

The scientists and the industry are facing this huge challenge to preserve or restore normal mechanics. Custom made implants may be ideal but still quite expensive despite new technologies which will make it affordable. The sagittal features of the femoral component may be the most important and may reduce the inventory of necessary standard implants on the shelf to cover most of the needs.

Some knees may require concomitant osteotomies, excision of cruciate ligaments and substitution and surgery as we perform it today.

But we must prepare the new generation of total knee replacement in order to get more forgotten knees with better function and still lasting 30 years.

Poster: 16
#473

Effect of Insert Conformity and Material on the Wear of Total Knee Replacement

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Wear of polyethylene in joint replacement continues to be a significant factor influencing the clinical performance of an implant. Historically, failure in total knee replacement (TKR) was commonly attributed to oxidative degradation reducing the mechanical properties of the material, resulting in fatigue and delamination. Improvements in material processing and sterilisation have resulted in more stable materials, and produced improved clinical outcomes. However, TKR is becoming increasingly used for younger, more active patients, which provides a new challenge of reducing surface wear to increase the osteolysis-free lifetime of the implant. This study has investigated the effects of bearing geometry and material on the wear of a TKR, with the aim of reducing volumetric wear.

The wear of TKR bearings were investigated using a physiological six station Prosim knee wear simulator (Simulator Solutions, UK). Six samples of each test configuration (Sigma CR fixed bearing knees (DePuy International, UK)) were studied (Figure 1). The central axis of the implant was offset from the aligned axes of applied load and tibial rotation to replicate a right knee. High kinematics, under anterior-posterior displacement control was used for this study [1]. High kinematics were defined as a maximum femoral axial loading of 2600N, flexion-extension of 0 to 58º, an anterior-posterior displacement of 0-10mm, and an internal-external rotation of ±5º. The lubricant was 25% (v/v) calf serum supplemented with 0.03% (v/v) sodium azide solution in deionised water, as an antibacterial agent, and was changed approximately every 0.33Mc. Wear was assessed gravimetrically and moisture uptake was assessed using unloaded soak controls. Volumetric wear was calculated using a density of 0.934mg/mm^3, and statistical analysis was performed using one-way ANOVA, comparing the data with a previous study [2].

The mean wear rate of the lipped GVF insert was 7.1±1.3mm^3/Mc, significantly lower than the wear rate of the curved GVF insert reported previously, and higher than the flat insert wear rate (ANOVA, $p<0.05$, Figure 2, [2]). The XLK polyethylene bearing had a significantly lower wear rate than the GVF material tested previously (ANOVA, $p<0.05$, [2], Figure 3).

The lower conformity lipped inserts had a lower wear rate than the curved inserts, but higher than the flat inserts previously studied, supporting the hypothesis that reduced conformity results in higher contact pressures and reduced contact area, leading to a reduced surface for wear to occur. There was a substantial reduction in wear rate for the moderately cross-linked UHMWPE compared with conventional material. Both design and material may significantly affect the wear performance of a TKR and provide options for a low wear knee.

1. McEwen *et al* JBiomechanics 2005

2. Galvin *et al* JBiomechanics 2009

Figures

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Figure 3

Poster: 17
#749

Review of Ceramic-Ceramic Bearings in Hydroxyapatite Ceramic Coated Hip Implants: a Clinical and Radiological Evaluation With Up to Twenty Year Follow-Up

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Introduction

Hydroxyapatite (HA) bridges the gap between living bone and a metal implant. An HA coated implant will physiologically bond to the host bone thereby fixing the implant.

Worn plastic components will cause debris disease contributing to aseptic loosening. Hard-Hard bearings should obviate this problem. Metal-metal will release ions which might be deleterious. Metal–metal resurfacing has high lighted problems arising from metal debris. High blood levels of metallic ions are of concern especially to women of child bearing age.

Ceramic bearings may fracture but otherwise appear free of complications.

Aims

To establish whether or not HA coated implants survive.

Will ceramic bearings produce uncomplicated function in younger, active patients?

Methods

This is a study extending over 20 years of 627 consecutive HA hip arthroplasties with ceramic bearings. The incidence of aseptic loosening, dislocation and broken implants has been particularly investigated.

Annual review has been performed using Harris Hip Score to assess pain and function, and X-rays to check osseointegration. Alumina ceramic was inserted in 467 hips. The newer Zirconia Toughened Alumina (ZTA) has been inserted in 169 hips.

Results

In this series of 627 HAC hips with ceramic bearings aseptic loosening is unusual (one stem, two acetabulae (3 of 1254 components, 0.24%) Failure from mal-orientation with repeated dislocation occurred in six hips (0.48%). Three alumina heads (0.48%) and two alumina liners (0.32%) broke. There has been no failure of ZTA ceramic. No patients have thigh pain. Osteolysis and debris disease have not arisen.

There are 198 hips still under review at 10 or more years.

Harris Hip Scores show 91.2% scoring over 90 or 100. Lower scores mostly relate to co-morbidities (other joint and medical problems).

Conclusions

Assessments confirm that patients remain well. HA bonding leads to a secure and long lasting fixation without the use of cement. Aseptic loosening of HA hips is rare at 0.24%. Failure from broken alumina components is unusual. Alumina has now been superseded by ZTA for implantation. Ceramic on ceramic is a reliable selection for bearing surfaces in patients of any age and either sex.

Poster: 18
#911

Total Knee Replacement in Obese Patients Enrolled in an Enhanced Recovery Programme

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Introduction

Obesity is a direct contributor to degenerative joint disease. As the prevalence of obesity increases we would expect the number of overweight patients presenting for knee replacement surgery to similarly increase. There are reports that overweight patients in the UK's National Health Service, typically with a Body Mass Index (BMI) over 30, are being denied operations on the premise that they are at risk of significant complications. Enhanced Recovery Programmes (ERP) are designed to enable patients to recover quickly and return home safely within a few days. The aim of this study was to compare the outcome of obese and non-obese patients enrolled in our ERP.

Methods

We prospectively studied 350 patients who underwent total knee replacements and were treated through our ERP form March 2010 to January 2011. The mean age was 69 (range 34-96 years). 192 patients (55%) were considered obese with a BMI of >30. 11 patients (3%) were considered morbidly obese with a BMI ≥40. They were age & sex-matched with the non-obese patients. Outcomes measured included: Length of stay, wound complications (including surgical site infections), deep vein thrombosis and blood transfusion requirements. Data was collected to 42 days following discharge.

Results

There was no significant difference in the length of stay between the obese (BMI 30-39) and non-obese (BMI<30) groups; 4.5 days (median 4) and 4.3 days (median 4) respectively. Admission time was prolonged in the morbidly obese group, with an average length of stay of 5.6 days (median 4). 4 patients (36%) in the morbidly obese group were documented to experience wound complications including oozing and haematoma formation which delayed discharged. There were no significant differences in surgical site infections, blood transfusion requirements, deep vein thrombosis incidence or other patient-reported outcome measures at 42 days.

Conclusion

There was no significant difference in the early post-operative outcome of knee replacements in patients with a Body Mass Index of less than 40 enrolled in the ERP. The morbidly-obese group demonstrated longer hospital stays and non-infective wound complications. However, there was no difference by six weeks. These patients should be encouraged to optimise their weight pre-operatively and counselled that their recovery may be longer. As a result of this study we would not withhold knee replacement surgery on the basis of elevated BMI.

Poster: 19
#447

Interference of Subjective Visual Vertical Perception on Standing Stability in Adolescence With Sclerosis: A Case Report

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Background:

Vertical perception is a key reference for maintenance of postural blance. Subjective visual vertical perception (SVV) is influenced by multiple factors such as body tilt, body position. Adolescents with idiopathic scoliosis (AIS) are characterized by apparent spinal deviation, and the postural parameters representing to postural balance was found to be altered in AIS . It's reasonable to doubt that the asymmetrical body alignment cause uneven weight-bearing, which may leads to abnormal postural control strategies and balance, subsequently compromise subjective visual or postural vertical perception. The present study is aimed to investigate the standing stability and SVV validity of an AIS girl.

Methods:

An AIS and a normal girl were measured of their standing stability by a pressure mat and SVV by computerized rod and frame test (cRAF test) designed by Docherty and Bagust in 2010. Standing stability is measured by amount of center of pressure displacement and speed. In a dark-room, the subject focus on the 32" crystal screen at eye-height while standing on the pressure mat and judge the verticality of the line (tilting from 0° to ±10° in randomized sequence) within the interference frame which is either a square or circle .The percentage of errors and validity was record simultaneously.. Independent *t* test will be used to compare between scoliotic and normal girl. Statistical significance is set at $p < .05$.

Results:

We hypothesize that the postural stability and behavior meaaure of the SVV is different significantly between AIS and norm girls..

Conclusions:

Interference of subjective visual vertical perception causes an effect on standing stability in adolescence with sclerosis. Body alignment is an important underlying factor to the subjective visual vertical perception.

Poster: 20
#1026

Early Results of an Elective Orthopaedic Rapid Recovery Program

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In 2009 the mean inpatient length of stay following elective primary joint arthroplasty at North West London Hospitals (NWLH) NHS Trust was 5.8 days following Total Knee Replacement and 5.5 days following Total Knee Replacement, compared to a national UK average of 6.3 days following THR and 6.1 days following TKR.[1]

In September 2010, a Rapid Recovery program was initiated to improve patient outcomes and speed up patient recovery following surgery. Postoperative treatment pathways are now delivered by multidisciplinary teams in order to accelerate post-operative recovery and reduce complications, morbidity and adverse events. Between November 2010 and April 2011, 6 Consultant Orthopaedic surgeons perfomed 52 primary elective total hip replacements and 122 primary elective total knee replacements using the newly implemented rapid recovery pathway. The mean length stay following total hip replacement was 4.3 days (median 3 days) and 3.8 days (median 3 days) following total knee replacement.

Preoperatively the patient is prepared physically and mentally for their procedure, with a thorough Consultant led pre-assessment process and a Joint Replacement School to prepare the patient for all aspects of surgery. Elective surgery takes place at a dedicated elective centre with all patients admitted on the day of surgery. A General or Spinal Anaesthetic is used (depending upon anaesthetist and patient preference / medical factors). Up to 100 mcg of Fentanyl, 10mg Morphine, and 1g paracetamol are given during the procedure. In addition local infiltration anaesthesia (LIA) consisting of a systematic injection of 40ml 0.75% ropivicaine, 30mg ketorolac with adrenaline in 60ml Normal Saline (or equivalent) is performed in all tissues exposed or incised during surgery including the deep capsular and ligamentous layers and superficial subcutaneous layers.[2] Following knee arthroplasty, a compression bandage is utilised for 24 hours to improve analgesia after LIA.[3]

Postoperatively pain is monitored by a dedicated pain team and controlled using a standardised analgesic ladder, with regular audit to maintain low pain and nausea scores and high patient satisfaction levels.

Patients are seen as soon as possible following surgery by a physiotherapist and started immediately upon an intensive program to allow early walking and active range of movement exercises.

All patients are discharged with a support package tailored to their individual need and telephoned at 48 hours to check progress, pain scores and pain medication compliance.

The outcomes and experiences following the implementation of the rapid recovery program show that great improvement may made be made in a short space of time with good leadership, careful organisation and a committed multidisciplinary team approach.

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Comparisons of Patellofemoral Joint Between Before and After ADVANCE Total Knee Arthroplasty: Using Three-Dimensional Digital Template Software Athena

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Purpose:

To evaluate and compare prosthesis orientation with conditions before operation is difficult, especially in patellofemoral (PF) joint. On the other hand, Advance® Medial Pivot (MP) (Wright Medical) total knee arthroplasty (TKA) had established to replicate normal tibiofemoral knee joint kinematics, medial-pivot knee motion. However, its influence to the PF joint remained unclear at present. The purpose in this study is to assess the PF joint conditions in Advance MP TKA, via radiograph and Three-Dimensional Digital Template Software "Athena".

Materials and Methods:

We performed ten ADVANCE MP TKA with the patients of osteoarthritis (OA). The rotational alignment of the femoral prosthesis was set at 3° of external rotation in relation to the posterior condylar axis and no lateral release has done in this study. At before and one month after surgery, skyline views at 30, 60, and 90° of flexion were taken, and patella shift and tilt were measured. Furthermore, pre-operative computed tomography (CT) was also taken. With 2D-3D registration techniques using Athena, implant orientations were matched with the preoperative CT and the changes in anterior part of femoral prosthesis were evaluated. The relationships between such morphological changes with radiographic measurements were evaluated.

Results:

Pre- and post operative condylar twist angles (CTA) measured using Athena were 6.0°±2.2 and 3.0±2.8, respectively. Pre- and post operative patella tilt at 30, 60, and 90 degrees of flexion were 8.5°±4.6, 6.1±3.7, 5.2±3.0, and 10.6±2.5, 9.1±2.8, 6.2±2.9, respectively. (plus means lateral tilt) Pre- and post operative patella shift were 1.9 mm±2.6, 0.4±1.9, -0.4±1.3, and -0.02±3.7, -1.1±1.7, -1.2±1.5, respectively. (distance from the deepest point of sulcus, plus means lateral shift) There were significant differences in patella tilt at 60°, patella shift at 30, and 60° between before and post-operation ($p<0.05$). CTA were statistically correlated with patella shift at 90°only ($p<0.05$). The anteromedial, and anterolateral differences between before and post-operation in distal femur was 0.5±3.5 and -2.1±2.1, respectively. (plus means prominence compared to the pre-operative conditions)

Conclusions:

The results in this study indicated ADVANCE TKA could improve lateral shift, however it did not affect to lateral tilt at one month post-operation. Evaluations using Athena revealed that the results of CTA was same as planned and that anterior part of femur changed to external rotation after operation, however the change did not lead to improve the congruity of patellofemoral joint in this study. We need further investigation, such as kinematics of this prosthesis and comparison with other prosthesis, to reveal reasons of the results in this study.

Poster: 22
#406

The Results of Cementless Acetabular Cup for Primary Osteoarthritis Compared With Avascular Necrosis of the Femoral Head

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Purpose:

Cementless total hip arthroplasty was performed to the osteoarthritis of the hip and avascular necrosis of the femoral head, and the clinical and radiological results were compared at the acetabular cup.

Materials and Methods:

The subjects of this study were 84 cases who underwent primary total hip arthroplasty using a cementless acetabular cup from March 1992 to May 2001. The 84 cases were followed up for at least eight years. The patients were divided into a degenerative arthritis group (A) and an avascular necrosis group (B). The A group consisted of 38 cases, and the B group 46 cases. The clinical evaluation was performed with reference to the Harris Hip Score (HHS), and the radiological evaluation was performed by observing the osteolysis and the acetabular loosening. The results were analyzed statistically.

Results:

The postoperative HHS of the A and B groups at the final follow-up were 92.1 and 91.2, respectively. The radiological results showed that there were 9 and 15 cases of acetabular osteolysis in the A and B group, respectively. The replacement was performed again in 2 cases in the A group and 3 cases in the B group, in which aseptic loosening was found.

Conclusion:

No significant clinical and radiological difference at the acetabular cup was found between the A and the B group in the cementless total hip arthroplasty. However, more studies should be conducted in the future since there was a high rate of polyethylene liner wear and osteolysis occurrence.

Poster: 23
#407

Treatment of Infected Hip Arthroplasty With Antibiotic-Impregnated Calcium Sulfate Cement

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Purpose:

To analyze the effectiveness of a vancomycin impregnated calcium sulfate cement bead insertion after debridement (of) an acute-immediate stage infected hip arthroplasty.

Materials and Methods:

Between 2002 and 2008, 13 patients with documented acute-immediate stage infection of hip arthroplasty were reviewed and followed for at least two years postoperatively(aveaver 4.3 years). The preoperative and postoperative clinical and radiologic findings and blood laboratory work were checked. All cases were performed through retention of the implant and massive debridement and saline irrigation. After that a vancomycin impregnated calcium sulfate cement beads was inserted.

Results:

After the first operation, the average interval for second operation was 27.7 days(17-37) . At the second operation, the erythrocyte sediment rate and C-reactive protein were 339.7 mm/hr (34.6 ~150.97 mm/hr) and 136.4 mg/L (41~132 mg/L) respectively. Infectious organism were cultured and isolated. There were 5 cases of Methicillin resistant staphylococcus aureus (MRSA). In addition, results of an antibiotics sensitivity test were 8 cases of Vancomycin, and 5 cases of 3rd generation Cephalosporin. Radiologic results showed 7 cases with stable fixation on last follow-up (femoral stem) and 1 case of hip joint space narrowing, acetabular erosion..

Conclusion:

Vancomycin impregnated, calcium sulfate, cement bead insertion for an acute immediate infection of hip arthroplasty proved to be a useful method.

Poster: 24
#408

Standard Type Cemented Hemiarthroplasty With Double Loop and Tension Band Wiring Technique for Unstable Intertrochanteric Fracture in Elderly

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Purpose:

To observe the follow-up results of standard cemented bipolar hemiarthroplasty with double loop and tension band wiring technique for treatment of unstable intertrochanteric hip fractures in elderly patients with osteoporosis.

Materials and Methods:

From May 2000 to May 2006, 86 cemented bipolar hemiarthroplasties were performed in elderly patients who had unstable intertrochanteric fractures. The mean age at the time of surgery was 82 years old. The average follow-up period were 5.3 years. We evaluated post-operative results after operation by clinical and radiographic methods.

Results:

Clinically, the final follow-up of Harrsi hip score was noted 79.2. The mean time needed for full weight bearing following surgery was 4.2 weeks and 82.5% of patients regained their preoperative ambulatory level. All patients achieved union in lesser trochanter fracuture, but great trochanter displacement were observed in 4 cases.

There was one case of acetabular erosion. Post-operative superficial infections were found in 2 cases. 1 case with stem subsidence(<5 mm) showed satisfactory results without further subsidence in follow-ups.

Conclusion:

If we properly apply indications in technique with cemented bipolar hemiarthroplasty in the treatment of unstable intertrochanteric hip fracture in elderly, we will achieve systematic postoperative rehabilitation, pain control and handy nursing which is its one of merits.

Poster: 25
#409

Isolated Liner Exchange With Cement and Allogenic Bone Graft in Revision Total Hip Arthroplasty

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Background:

In total hip revision arthroplasty, isolated liner and head exchange has proven successful in treating polyethylene wear and osteolysis in select patients, with better bone preservation and reduced morbidity compared with complete acetabular component revision. However, high dislocation rates have been reported by several authors. In this study, clinical results and complications were evaluated after liner exchanges.

Methods:

We retrospectively analyzed 31 hips (31 patients). There were 15 men and 16 women of average age 56.5 years

(range, 32-79 years) at the time of the revision surgery. The mean duration of follow-up was 4 years (range, 2.1-8.5 years). All of these patients were evaluated clinically and radiographically with special attention to wear and dislocation according to approach and insert technique. After inserting allogenic bones through empty holes into pelvic osteolysis, we replaced the liners of old components with new polyethylene liners and 28mm CoCr heads.

Results:

Clinically mean Harris hip scores improved from 61.7 (range, 56- 80) preoperatively to 84.9 (range, 70-97) at final follow-up. Postoperative complications included dislocation in 3 hips), high rates of linear wear in 2 hips (0.206mm/year), and intraoperative greater trochanter fracture in 3 hips (14.2%). Especially, posterior dislocations occurred in all cases which used posterior approach, but here was no statistical significance (p=0.070). Two of 3 dislocations, the liner were intentionally placed with posterior part elevated, but dislocation occurred. Among one of them, in which an HA-coated smooth cup with multiple holes, the metal shell had inadequate bone ongrowth and when dislocation occurred, the metal shell was dislodged from the pelvis. And, the cases of rapid wearing of the liners seem to have been caused by uncontained or inappropriate placement of liner into a small metal cup with its diameter of less than 48mm. Even when using into a metal shell with a broader diameter of over 48mm, it was observed that the use of inappropriately thin liners with a thickness of 3mm less than original liners resulted in the rapid wear of the liners. There were no cases of progression of previous osteolytic lesion in the pelvis at last follow-up.

Conclusion:

An isolated liner and an allogenic bone graft were found to be a simple, effective means of treating liner wear, pelvic osteolysis and improving patients' recovery. However, it concerns needed in patients who had taken a HA-coated smooth metal shell, small-sized metal shell with a diameter of 48mm, intraoperative use of an inappropriate thinner liner for the metal shell and intentional change for liner position. When there are no clinical abnormalities such as malposition of metal cup or dislocation, intentional change and fixation of liner position by surgeon instead of liner containment with the metal shell may cause the neck-cup impingement and the early wear of liners. Furthermore, we suggest that long lasting cemented liners and large femoral heads may overcome these complications.

Level of Evidence:

Therapeutic level III-1(case-control study). See instructions to authors for a

Complete description of level of evidence.

Poster: 26
#410

The Fate of Rough Blasted Cemented Femoral Stem in Second Generation of the Metal on Metal Total Hip Arthroplasty

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Background:

We observed early osteolysis and loosening of the rough surface-cement stem with a second generation metal-on-metal articulation. This study was to investigate the possible etiologic role of stem loosening and osteolysis by examination of the surface of the rough blast cement and related periprosthetic tissues that have been retrieved at revision.

Methods:

We retrospectively analyzed 39 hips (37 patients) with use of metasul metal-on-metal total hip arthroplasty. Of the femoral stem, rough surface-cement stem used in 18 hips and cementless Ti-alloy stem in 21 hips. The mean duration of follow-up was 10.2 years. Of these eight rough blast cement stem were revised, seven in loosening and one in recurrent dislocation. By using energy disperse spectroscope and back scattered electron image, histologic studies were performed to the samples of periprosthetic tissues. Skin patch tests for metal hypersensitivity were done to select patients.

Results:

All of cementless stems and cups showed excellent results at the last follow-up. However, eight cement hips were revised. Light microscopy showed polishing effect on retrieval femoral stem affected by the rotational force. Periprosthetic tissues samples were investigated using EDS and BSE images revealed that there were abundant cement and related metal particles with size of 5-10ãï¿½ï¿½. However there were few metal particles and had greater size (20-100ãï¿½ï¿½) in periprosthetic tissues. Histologic finding shows perivascular infiltration of lymphocytes and accumulation of macrophages No relation was found between skin patch tests and loosening.

Conclusion:

These findings raise the possibility that early osteolysis and loosening in patients with metal-on-metal hip replacement were associated with rough blast surface cement stem. These mixed particles such as Fe and Zr maybe trigger lymphocytic reactivity suggestive delayed type hypersensitive reaction. This study suggests that cement stem which have rough blasted surface should be considered in metal-on-metal total hip arthroplasty.

Level of Evidence:

Therapeutic level III-1(case-control study). See instructions to authors for a complete description of level of evidence.

Poster: 27
#411

Cementless Hemiarthroplasty in Patients Older Than 70 Years Age

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Introduction

Cementless hip arthroplasty is an accepted alternative to hip arthroplasty with cement in younger

patients, but it remains controversial in elderly patients. The purpose of this study was to evaluate the clinical and radiographic outcomes of cementless proximally coated femoral stem in patients who were at least seventy years of age at the time of the operation.

Materials and Methods

A retrospective study was taken on 45 patients, that is, 45 hips aged 70 years or older at the time of operation in hip fractures including femoral neck and intertrochanteric fractures. The average follow-up duration was five years-ranging from 2 to 11 years. The clinical evaluation was taken on the basis of Merle d'Aubigne and Postel's modified Charnley method and Harris Hip score, used before and after operations. Daily living activity scale graded 6 points according to Kitamura methods. The radiographic evaluation was focused on the state of the fixations of the femoral stem with osteointegration, radiolucent line around stem, pedestal sign and stress shielding effects. It was considered to fail if the femoral component was revised against loosening.

Results

Clinically the difference between preoperative and postoperative Harris hip score was 42 points, and the final follow-up points was 82 on average- ranging 72-96. The Merle d'Aubigne and Postel scale were 3.0 and 1.4 points, respectively. The daily activity level was lowered approximately to grade 1.6 by Kitamura methods one year after operations. As complications, there were six hips of proximal femoral fractures during operations, and three dislocations and two superficial infections after operations.

All of the femoral components were radiographically stable and showed bone ingrowth 6 weeks later. No femoral component was revised.

Conclusions

Bipolar hemiarthroplasty using a cementless porous coated femoral stem in the elderly has been regarded as safe and effective treatment. However, it is advised to take good care of the patients with dementia and adduction contracture in case of cerebrovascular stroke because this disease may be complicated dislocation.

Poster: 28
#748

Comparison of Longterm Results of Highly Crosslinked Polyethylene vs Conventional Polyethylene

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Comparison of Long Term Results of Clinical and Wear Performance of Highly Crosslinked Polyethylene and Conventional Polyethylene in Primary Cementless Total Hip Arthroplasty

Background:

Highly Crosslinked polyethylene is the most commonly used articulation in total hip arthroplasty. Hip stimulator studies, short and midterm studies have suggested that wear rate of highly crosslinked polyethylene is significantly less than conventional polyethylene. The aim of this study is to identify any difference in the wear performance and clinical outcomes between highly crosslinked polyethylene and conventional polyethylene in the long term.

Methods:

One hundred patients who had undergone Primary Cementless Total Hip Arthroplasty were enrolled in a Retrospective Study. Fifty patients were in each group. Patients were assessed clinically and radiographically at postop 6weeks, 3months, 6months and annually thereafter. Clinical assessment was performed using Harris Hip Score. Radiographic analysis included measurement of acetabular component position, polyethylene wear and evidence of osteolysis using a validated radiographic technique (Dorr Method). Statistical comparison of polyethylene wear was performed with the use of generalized estimating equations

Results:

At a mean of 9.8years (96 to 108 months for Conventional PE), and 8.6years (96 to 131 months for HCLPE), clinical results as determined by Harris Hip Score did not differ between highly crosslinked (95.8) and conventional polyethylene (96.7)groups. The mean bedding in penetration of highly crosslinked PE (0.064mm) was significantly lower than conventional PE (0.224mm).The subsequent penetration with elimination of the bedding in wear, resulted in a reduction in annual linear wear rate in highly crosslinked PE compared to conventional PE by 85% . Mean linear wear rate according to age was significantly different in bivariate correlation analysis($p<0.05$) between two groups . Correlation between wear rate and sex was not statistically different between the two groups(Male : Female 0.151 :0.144 and 0.032 : 0.033 respectively for conventional and HCLPE groups) in bivariate correlation analysis ($p=0.666$). Osteolysis was reported in five patients in the conventional PE group and none in the HCLPE group. There were no cases of loosening or crack reported in both the groups.

Conclusion:

At a minimum of 9.8 years of follow up, annual linear wear rate of HCLPE was 85% lower than conventional PE . There was no concerned complications, osteolysis and crack in the HCLPE group where as five cases of osteolysis in conventional PE. There was no different in the clinical outcome between two groups.

Level of Evidence:

Therapeutic Level III: Retrospective Comparative Study

Poster: 29
#975

Resurfacing Arthroplasty in Bilateral Avascular Necrosis of Humeral Head With Massive Rotator Cuff Tear -a Case Report-

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Humeral head resurfacing arthroplasty has evolved into a reliable method of shoulder arthroplasty designed to restore the natural anatomy of an arthritic or damaged articular humeral surface with minimal bone resection which is important in active or young patients with shoulder arthritis. A unique case in a 65-year-old female Caisson's disease patient with bilateral avascular necrosis of humeral head with massive rotator cuff tear. Her right and left shoulder were stage III and IV, respectively according to Cruess classification. Postoperatively, the patients reported significant pain relief. Serial radiographs until 2 years postoperatively showed no evidence of component loosening, including radiographic lines around the fixation component, osteolysis, or device migration. Resurfacing arthroplasty of the humeral head for the patient with advanced-stage osteonecrosis has shown it to be one of the effective options in relieving pain and restoring function.

Key words: Avascular necrosis, massive rotator cuff tear, humeral head, resurfacing arthroplasty

Poster: 30
#1001

Long Term Performance of Metal on Metal Hip Resurfacing Arthroplasty in Asian - 7 to 12 Years Follow Up -

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Background

The purpose of this study was to determine the clinical and radiologic results after MoM HRA at long term follow up and the prevalence of the complications following MoM HRA in Asian.

Methods

Between December 1998 and May 2004, 164 hips of 146 patients underwent MoM HRA using Birmingham Hip Resurfacing System® at single center. 151 hips (38 hips of female, 113 hips of male) of 134 patients have been reviewed for at least 7 years. Mean period of follow-up was 105.8 (84-149) months. Preoperative diagnoses were mainly osteonecrosis of femoral head (ONFH) (107 hips, 70.9%). Their mean age at the time of operation was 37.4(16-68) years old. Clinically, Harris hip scores (HHS) and UCLA activity scores were evaluated. Radiologically, radioluscencies around implants, narrowing change of retained neck, impingement, stress shielding, and heterotrophic ossification were evaluated in the serial anteroposterior and groin lateral radiographs of hip.

Results

Clinically, average HHS was improved from 82.3 points to 98.5 points at last follow-up. Average UCLA activity score at last follow-up was 9.0 points. Ranges of motions at last follow-up were very satisfactory. There was no patient with severe pain around hip joint, especially groin area, but only 6 patients complained mild discomfort at buttock or groin area. Radiologically, radiolucency was shown around the acetabular component in 2 cases and around the stem of femoral components in 3 cases. Narrowing changes of retained femoral neck were noticed in 3 cases. There were impingement signs in 6 cases and only 2 cases of them had mild discomfort around inguinal area (Pain HHS 40/44). We found only 1 case of osteolysis at Gruen zone III of acetabulum, but loosening of cup has not happened up to 9 years after surgery. Heterotrophic ossification was found in 1 case. There was no case with hip dislocation, infection or pseudotumor. Revision surgeries after the primary resurfacing arthroplasty were performed in 4 cases (2.6%). Survival rate of MoM HRA was 97.4% at 12 years. Two hips were revised to the conventional total hip arthroplasty because of loosening of acetabular component. Two cases of femoral neck fracture were revised to total hip arthroplasty using big metal femoral head with retained acetabular component.

Conclusions

MoM HRA demonstrates good survival rate for 12 years, even though majority of them were with ONFH. Most of patients show excellent clinical results with high level of activity score. Prevalence of complications which can

be happened in patients with THA is extremely lower than concern and the allergic reaction to the metal ion, especially pseudotumor, have not been found at long term follow up. Safety of MoM HRA is comparable and performance they have shown is much superior to that of THA. MoM HRA still can be a good alternative to THA in young or active patients with coxarthrosis.

Poster: 31
#510

Short Term Result of 36 Mm Femoral Head Ceramic on Ceramic Total Hip Arthroplasty

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Purpose:

To evaluate the short term result of 36 mm femoral head ceramic on ceramic total hip arthroplasty.

Material and Method:

Fourty three hips, 40 patients operated from August 2005 to February 2008 with 36 mm femoral head ceramic on ceramic total hip arthroplasty was evaluated. The average age was 56(28-82)years old, with minimum follow up of 3 years was included. Most common preoperative diagnosis was osteonecrosis with 21 cases. Clinical and radiologic results were evaluated.

Results:

HHS improved from 43.4 to 88.1 after 3 years. Average ROM onproved to flexion 113 degrees, abduction 30 degrees, adduction 24 degrees, external rotation 36 degrees and internal rotation 12 degrees. Average leg length discrepancy was 3 mm. The anteversion of the acetabular cup was between 9 to 18 degrees and inclinations was between 33 to 58 degrees. The average VAS pain score was 2.2 and 4 patients complained of mild thigh pain.Three patients complained of squeaking. One dislocation occurred after a heavy fall 1 week after surgery and one acute infection occurred which was controlled with irrigation and debridement. There were no osteolysis or loosening or ceramic breakage. There were no cases of revision at last follow up.

Conclusions:

The 36 mm femoral head ceramic on ceramic total hip arthroplasty shows good result in short term evaluation.

Poster: 32
#849

THRA in Osteonecrosis of the Femoral Head Combined With Femoral Nerve Palsy

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Iliopsoas bursitis is known to occur relating to hip joint lesions such as osteoarthritis, rheumatoid arthritis, synovial chondromatosis, pigmented villondoulnar synovitis and rarely osteonecrosis of the femoral head, and femoral nerve palsy due to iliopsoas bursitis is very rare. We experienced a patient who had acutely developed anesthesia of anterior thigh. He already had far advanced ostenecrosis of the femoral head and slowly grown inguinal mass (3 X 5) was detected 2 weeks ago. Femoral nerve was paralyzed by distened iliopsoas bursa confirmed by ultrasonography and enhance MRI. Cementless Total hip replacement arthroplasty through posterior approach was done after removal of connected iliopsoas bursa by irrigation & curettage. Anesthesia of anterior thigh was improved immediately after operation and femoral nerve palsey was recovered slowly for 2 months. Cemetless Metal to metal Magnum hip THRA(Biomet® USA) was healed uneventfully and followed up for 3 years . We report a case of femoral nerve palsy due to iliopsoas bursitis related to AVN of femoral head with

references.

Poster: 33
#978

Resurfacing Enables Faster Top Walking Speed and Longer Stride Than Replacement on an Instrumented Treadmill

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Abstract:

Introduction

Hip resurfacing arthroplasty (HRA) has been promoted as an alternative to standard total hip arthroplasty (THA), enabling patients with coxarthrosis to pursue higher levels of function. However, patient reported outcome measures and gait analysis have failed to distinguish between them at normal walking speeds.

Our null hypothesis was that the type of arthroplasty would not predict postoperative top walking speed, and that there would be no difference between the operated and un-operated hip. The study was powered to detect a 5% difference.

Method

A case control study was performed using 63 subjects (21 THA , 21 HRA, 21 healthy controls, all matched for age and gender.) The experimental groups were a minimum of 24 months after their hip arthroplasty. All had been performed through a posterior approach, and had been discharged from routine follow up by the two senior authors, one who performs HRA when appropriate, and the other who has only ever used THA.

On an instrumented treadmill (Kistler Gaitway, Kistler Instrument Corporation, Amherst, NY) each subject was measured by a researcher blinded to which procedure the patient had undergone. After a 6 minute acclimatization period at 4km/hr, the speed was then increased incrementally until either the subject felt uncomfortable, or gait symmetry had deteriorated. At all intervals, measurements were taken for both limbs including: speed, cadence, stride length, step length, impulse, progression angle, base of support, maximum forces at heel strike, mid-stance and push off. The procedure generally took 12 minutes of continuous walking and was completed without difficulty by all subjects.

Results

The two experimental groups were well matched for age, sex, Oxford Hip Score (HRA 45 vs. THA 46), BMI (29.4 vs. 29.5), leg length (91.7 vs. 91.5cm) and at preferred walking speeds were indistinguishable. However at top walking speed (TWS) the HRA group were able to walk significantly faster, achieving a mean of 2.08m/sec (range 1.39 -

2.50) compared to THA with a mean of 1.89m/sec, (range 1.53-2.22 p=0.01). This 9% difference appears to be due to a longer stride length at higher speeds (173 vs 163 cm) and higher cadence (141 vs 136 steps/min). Of the other variables, the peak force asymmetry recorded in the THA group at heel strike did not reach significance. The mean

gait cycle at top speed of the two groups is illustrated(Figure 1).

Discussion and conclusions

This small, blinded, case control study is the first to focus on high end performance following hip arthroplasty, encouraging patients to achieve as high a speed as they comfortably could. The THA group in this study walked 9% faster than the previously published top speed of 1.73m/sec, however the HRA group still walked 9% faster again,

matching the normal controls for speed and stride length. At higher speeds, in the THA group, the operated leg was spared peak loads at heel strike, while the HRA and control groups remained symmetric (figure 1). This is not randomised data, but the use of age and sex matched patients and a control group allow some tentative

conclusions to be drawn. The use of an instrumented treadmill has been shown to be a useful tool, providing reliable continuous data at higher speeds than can be achieved in a conventional gait lab. For patients who are interested in higher performance, this data suggests that an HRA may enable a more normal gait at higher speeds.

Figures

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Figure 1

Poster: 34
#1113

Robots and the Next Generation of Knee Arthroplasty

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21 years ago, Hap Paul inspired two young researchers with his description of the prototype robodoc which was just entering human trials after his animal trial of robotic hip arthroplasty.

His inspiration has led to the development of several generations of software and hardware in the field. The software that we initially used to measure how accurately we had undertaken robot assisted surgery was developed that have allowed the detailed description of different sorts of hip and knee pathology. The hardware we developed has enabled bone to be precisely milled using a high speed cutter to any shape needed.

This paper sets out the investigations into knee pathomorphology and kinematics, and the design implications for the next generation of partial knee replacements.

Poster: 35
#1047

Mobile Bearing Total Knee Arthroplasty: Where Does the Manual Instrumentation Fail to Provide a Correct Alignment?

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Introduction:

Malalignment of the prosthetic components can lead to early loosening, polyethylene wear and poor functions. Computer-assisted surgery (CAS) Total Knee Arthroplasty (TKA) has been developed to improve the accuracy of positioning of components. Several studies document the ability of navigation system to improve final alignment of components as compared with standard instrumentation, but no studies were to determine the alignment of each component and to detect whether tibial or femoral components are of higher risk of malpositioning in standard TKA.

Methods:

279 patients with primary gonarthrosis were divided into two groups: conventional technique (124) and CAS group (155). All patients were operated with an uncemented posterior cruciate ligament sacrifing mobile bearing TKA.

All patients were evalued by full-length weight-bearing radiographs: and the following measurements were done:

Angle A represents the tibia component placement against the mechanical axis of the tibia and angle D against the

mechanical axis of the lower limb.

Angle B represents the placement of the femoral component against the mechanical axis of the femur, whereas angle C against the mechanical axis of the lower limb

Angle E represents the above angle subtended by the mechanical axis of the tibia versus mechanical axis of femur in the coronal plane.

The optimum placement of the components was considered as follows:

1) The angle between the mechanical axis tibia and mechanical axis femur is within the limits of ±3° on the coronal x-rays.

2) Placement of tibial and femoral component perpendicular (±3°) to the mechanical axis of the lower limb and mechanical axis of the tibia or femur shaft on the coronal x-rays.

The data were analysed using *t-Student* test for statistical significance ($P<0.05$).

Results:

Angle

Standard group		**CAS group**		***t-Student test (P)***	
	Range (mean)	good outcomes n, %	Range/mean	good outcomes n, %	Standard and CAS	good outcomes
A (tibia)	85.0-94 (90.21)	90, 72,5%	86.0-95.0 (89,77)	131, 84.51%	0,1158	0,1454
B (femur)	86.0-98,5 (92,04)	73, 58,87%	88.0-95,5 (90.37)	141, 90,96%	<0,001*	0,0239*
C (femur)	83-94.0 (90,78)	100, 80,64%	86.5-93.0 (89,95)	149, 96,75%	<0,001*	0,002*
D (tibia)	86-96,5 (90,58)	98, 79,02%	87.0-93,5 (90,29)	147, 94,83%	0,2544	0,3165
E (coronal axis)	0.0-9 (2.66)	83, 66,93%	0.0-6.0 (1.33)	139, 89,67%	<0,001*	<0,001*

Discussion and conclusions

We found a statistically significant difference in femoral component positioning in CAS group and not in tibial component. This can be attributed to the need in using the intramedullary rod in standard technique.

The variable sagittal bow of the femur, the variability in canal diameter and the length, the point of entry of the rod, and diameter of an intramedullary guide can influence the initial distal femoral saw cut in the conventional technique despite a careful pre-operative planning.

The results of this study reveal that superiorly in standard TKA the component of higher risk of malpositioning is the femur, which the surgeon should pay more attention.

Poster: 36
#1048

Accuracy of Manual Instrumentation in Tibial Resection in Arthroprosthesis of the Knee: Evaluation With Navigator.

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Introduction:

Computer navigated total knee arthroplasty (TKA) is aimed at improving accuracy in the positioning of prosthesic components.

The aim of this study was to verify accuracy of conventional instruments in the tibial resection of total knee arthroplasty by evaluation with the navigator, to obtain an estimate of the error of manual positioning the resection guide, of the effective resection plane and of the effect of the impacting of the prosthesic components, both on the frontal and sagittal plane.

Methods:

Forty primary total knee arthroplasties were performed by the same senior surgeon. The resection guide was positioned first with conventional instruments and before executing the osteotomy, the accuracy of the guide positioning was evaluated by the navigator. The alignment measure was then repeated after resection, evaluating the difference between values suggested by navigator and those obtained after the resection, and also after component implantation, thus quantifying the deviation due to the procedure of component positioning.
Results: On the frontal plane, in only 15% of cases an error exceeding 1,5°, that has been considered the maximum value to obtain satisfactory results, has been identified in positioning of the tibial resection guide. The error was even lower when considering the effective resection plane, with unsatisfactory results in just 10% of cases.
Statistical analysis of the data observed on the frontal plane indicates that both manual postioning of the guide error and effective resection plane error tend to induce an error towards the varus.
On the sagittal plane, Statistical analysis highlighted that both manual positioning of the guide and effective resection plane tend to loose slope degrees , with unsatisfactory results in 45% and 40% of cases respectively.
The deviation between the bone resections and the subsequent implant placement were >1,5° in 0% both in the frontal and sagittal plane.

Discussion and Conclusion:

This study confirm the good reliability of the manual instrumentations in performing TKA.
However in each phase of the procedure a trend towards a varus positioning and loosing slope degree was observed. Even if the error could be extimate of little relevance, in case of eventual summation , they may become of clinical relevance. The observation that the data regarding the Sloop presents greater dispersions than that regarding the Varus/Valgus, in the analysis of both manual positioning of the guide and effective resection plane errors, seems to demonstrate that it is more difficult for the surgeon to perform a resection in the sagittal plane than in the frontal plane.

Conclusion

The advantage in the use of the computer assisted technique is than the opportunity to verify the resection at each

phase, enabling the surgeon to effect eventual corrections, thus limiting the potential for significant deviations which may occur adding surgeon and instrument's errors. Care should be taken to avoid varus positioning of the guide and the loss of slope degree, wich appears the most critical stages of the procedure.

Poster: 37
#1049

The Education Role of Navigation System

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Introduction:

Correct component positioning is an accepted factor for the successful of Total Knee Arthroplasy (TKA). Several studies had demonstrated that CAS improve accuracy of components positioning. We could speculate that the use of the computer assisted technique can improve surgeon's ability in positioning of the components with standard technique.

The purpose of this study is to demonstrate the educational role of the navigation system to obtain a better alignment of the prosthetic components with standard instrumentation after a CAS experience.
Methods: 150 patients with primary gonarthrosis were selected for unilateral TKA and operated with an uncemented posterior cruciate ligament sacrifing mobile bearing TKA by the same surgeon, with more 10 years experience with TKA. They were equally divided in three groups: group A (operated with conventional technique by surgeon without CAS experience); group B (operated with CAS by the same surgeon); group C (operated with conventional technique by the same surgeon after CAS experience).

We valued by full-length weight-bearing radiographs the overall alignment of the lower limb in the coronal plane. The optimum placement of the components was considered when the angle was within the limits of ±3° varus/ valgus on the coronal x-rays.

The data were analyzed using t-Student test for statistical significance ($P<0.05$).
Results: In the group A 34 patients (68%) had the overall alignment of the lower limb within the limits of ±3° on the coronal x-rays, in the group B they were 46 (92%) and in the group 41 (82%).
This difference is statistically significative regarding group A and group B ($P < 0,001$), group A and group C ($P=0,0469$), but not for group B and C ($P=0,051$).

Discussion and Conclusion:

The aim of this study was to compare the outcomes of conventional surgery before and after a CAS experience. In the present study 92% of all navigated TKAs were implanted within the range of ±3° varus/valgus, while just 68% of the group A met this criterion. However after CAS experience 82% of prosthesis were correctly implanted. Therefore the navigator seems to have an important role in improving the operating technique of even expert surgeons, offering them continuous opportunities to verify the precision of each single surgical step and of their capacity to verify the correct alignment.

It is, further, capable of indicating which are the most delicate phases of operation, to be executed with the most attention due to the greater risk of errors, taking on, thus, a fundamental didactic role.
We believe that the navigation system has an education role to improve the ability of surgeon of positioning prosthetic components precisely.

Poster: 38
#1046

Rotational Alignment of the Femoral Component in Total Knee Arthroplasty Using Navigation System. a Ct Study

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Introduction:

Rotation of the femoral component in total knee arthroplasty (TKA) is important for the balancing of the knee and the patellar femoral joint. Though it is shown that computer assisted surgery (CAOS) improves the anteroposterior alignment in TKA, it is still unknown whether navigation helps in finding the accurate rotation or even improving rotation.

The purpose of our study was to evaluate the difference between intraoperative computer guided femoral rotational alignment with the actual postoperative femoral position, measured using CT scan.

Methods:

16 patients have been selected with primary gonartrosis and submitted to TKA with technique computer assisted. All the patients underwent a CT scan and the measurement was done using a protocol developed based on recommendation by the navigation system.
We recorded the intraoperative data of the femoral rotation alignment component respect to whiteside line, epycondilar axis and the posterior condylar axis with the navigation system. We compared that values with those obtained with CT scan using the condylar twist angle(between the epycondilar axis and the posterior condylar axis)

Results:

For the rotation of the femoral component evaluating interepycondila angle, we have considered optimal results those inclusive between the 0° and the 3° of extra rotation. The mean of the epicondylar angle measured on he CT scan was 3.1°(range : 0.1°- 4.5°) and the computer data was 1.7°(range: -0.8 - 4.2). The difference was statistical significant ($p < 0.05$)

Discussion:

Accurate positioning of the components in TKA is important. The rotation of the femoral component in particular influences the final outcome due to its role in flexion stability, kinematic and patellar tracking. The use of navigation system in TKA showed more accurate AP alignment. However little is know about the effect of CAOS navigation system on rotation alignment. The intraoperative position of the femoral component of the knee protesis, as determined by the CAOS system, differs from the actual position of the knee prosthesis as measured on a postoperative CT.

Conclusion:

In conslusion, the intraoperative CAOS measured rotation of the femoral component differs from the postoperative CT measured position in particular for the interepicondylar axes. CAOS can probably help to achieve the optimal position of the femoral component but continuous improvement in methods to accurately

identify the rotational position and establish the ideal rotation of the components in total knee arthroplasty is still needed.

Poster: 39
#731

The Clinical Relevance and Validation of a Novel Technique to Measure the Abductor Moment Arm of on a Pelvic Radiograph

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Summary sentence

A novel and repeatable technique to accurately measure the abductor momentarm on a pelvic XR is associated with gait aberrations in case of decrease of the abductor moment arm following hip resurfacing.

Abstract

Introduction

The gluteus medius is the most important hip abductor and lack of reconstruction of its abductor moment arm (AMA) has been associated with impaired survivorship. The aim of this study was (1) to assess the most relevant AMA on a pelvic radiograph by means of a validated hip model and (2) to document whether gait aberrations are correlated with a lack of reconstruction of the AMA.

Methods

A cadaver hip model was generated and validated by means of CT-models. The AMA lengths during unipodal stance were calculated. The insertion sites of the 3 parts of the medius were marked and visible on pelvic XR. The radiographic AMA was compared to those calculated with the 3D models. Inter- and intra-observer reliability was tested on 54 pelvic radiographs following hip replacements. Twelve unilateral hip resurfacings >12 months post-operatively and a contra-lateral non-arthritic hip were assessed with 3D gait analysis.

Results

The middle part had the longest AMA (55-60mm). This part could be identified on pelvic XR with a very low inter- and intra-observer variability. Six of 30 total hip replacements (20%) and 13 of 24 (53%) hip resurfacings had a decrease in AMA. This was associated with an increase in contact stress of 6-9% and with significant correlations with pelvis, hip and trunk gait parameters. Stair descent and ascent were most significantly affected.

Conclusion

The presented measurement technique of the AMA is valid and changes in AMA length are associated with increased contact stresses and gait aberrations following hip replacement.

Poster: 40
#732

Lack of Accurate Reconstruction of the Femoral Biomechanics Is Associated With Increased Contact Stresses and Gait Aberrations Following Hip Resurfacing

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Summary sentence

Conversion to a total hip replacement should be considered if the femoral offset cannot be reconstructed with a hip resurfacing because this will lead to gait aberrations and increased contact stresses of the articulating surface.

Abstract

Introduction

Whether a precise biomechanical reconstruction of the hip can be best achieved with hip resurfacing (SRA) remains a topic of debate because an adequate femoral reconstruction can sometimes be hard to achieve. The aim of this study was (1) to estimate the contact stresses in a SRA cohort by means of a validated hip model and (2) to document whether gait aberrations following SRA are associated with a lack of restoration of the femoral biomechanics.

Methods

A cadaver hip model was generated and validated by means of CT-models input into musculoskeletal models to assess the contact stresses following SRA thereby taking into account the effects of socket inclination and anteversion, the femoral offset and abductor moment arm (AMA) changes. Twelve out of 24 unilateral SRA >12 months post-operatively and a contra-lateral non-arthritic hip were assessed by means of 3D gait analysis.

Results

Thirteen of 24 SRA (53%) had a decrease in AMA of 4mm. This was associated with an increase in contact stress of 6-9%. Accumulative errors of both component placements lead to contact stress increases of 20% relative to the most optimal reconstruction for that particular hip, which could be estimated by means of the native biomechanics of the normal contra-lateral hip. Significant correlations of AMA decreases with gait parameters were found at the pelvis, hip and trunk. Stair descent and ascent were most significantly affected.

Conclusion

Restoring the femoral biomechanics of the hip joint is mandatory to prevent high contact stress and gait aberrations following SRA.

Poster: 41
#736

A Low Complication Rate With Anterior Total Hip Arthroplasties Conducted on a Regular or Table.

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Summary sentence

The complication rate of THA conducted trough the direct anterior approach on a regular OR table is a safe and reliable surgical technique, with an expected learning curve of 50 cases.

Abstract

Introduction

Total hip arthroplasty (THA) conducted trough the direct anterior approach (DAA) has been associated with many advantages such as an improved post-operative recovery. However, the use of a traction table has been reported with a high complication rate. The aim of this study was (1) to document the complication rate of a multi-centre series of 400 THA on a regular OR table in supine position and (2) to document the surgical learning curve of the first 150 cases of a surgeon who converted to this technique from the direct lateral approach in lateral decubitus.

Methods

The component position and complication rate of 250 THA conducted by an experienced surgeon between January and December 2010, were reported. The operation time, blood loss, transfusion rate, hospital stay, component position and complication rate of the first 150 cases of a surgeon who used the same technique, were reported.

Results

The mean socket inclinations were 42° and 39°, respectively. The overall, experienced and learning curve complication rates were 4%, 2% and 7%, respectively. The latter dropped to 2% after the first 50 cases. There were 10 (2.5%) intra-operative complications that resolved without any consequence: 1 in the experienced (0.4%) and 9 in the learning curve series (6%). There were 5 post-operative complications requiring surgery (1.3%) and 1 dislocation requiring closed reduction (0.3%).

Conclusion

Total hip replacement can be conducted safely through the DAA on a regular OR table and is associated with a very low complication rate beyond the first 50 cases.

Poster: 42
#737

The Prognosticators for Intermediate Term Osteoarthritis of the Hip Following Slipped Capital Femoral Epiphysis

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Introduction

Screw fixation as the treatment of choice of Slipped Capital Femoral Epiphysis (SCFE) aims to stabilize the slipped epiphysis onto the metaphysis in order to prevent the metaphysis from further displacing. The purpose of this retrospective study was threefold: (1) to evaluate the minimum 11 year functional outcome scores of patients with SCFE, (2) to evaluate the incidence of intermediate to long-term osteoarthritis of the hip in patients with unilateral SCFE and prophylactic pinning of the contralateral hip and (3) to identify the prognosticators for osteoarthritis and functional outcome following SCFE.

Materials & Methods

Seventeen male and 14 female patients with a mean age of 30 years (range, 23-40), were clinically, functionally and radiographically evaluated at a mean follow-up of 17 years (range, 11-27). In total 35 hips with SCFE were assessed of which 27 were unilateral and 4 bilateral cases. Six hips (17%) were classified as unstable.

Results

The mean VAS for pain and functionality were 1.7 and 8.9 resp. Only 8 patients (25%) were completely pain free and fourteen (45%) were not restricted in their functionality. The mean Harris Hip score (HHS), UCLA and Tegner scores were 87, 9 and 5 respectively. Nine SCFE hips (31%) had a positive FADIR test in comparison to only 2 hips (6%) in the prophylactic group. Patients with a positive FADIR test had significantly higher VAS for pain and significantly lower HHS scores.

Two unstable hips were converted to THP. Unstable hips had a 3.4 relative risk for conversion to THP in comparison to stable hips. The mean Tonnis classification for osteoarthritis was 1.25 in the SCFE group and 0.42 in the prophylactic group ($p<0.0005$). Nine (28%) hips in the SCFE group and 1 in the prophylactic group had degenerative changes of grade 2 or more according to the Tonnis classification.

The MPFA was 77° in comparison to 85° in the prophylactic group ($p=0.0009$). MPFA <81° was associated with a significantly more degenerative changes ($p=0.02$). Hips with displacement of the anterior metaphysis beyond the anterior epiphysis had a significantly lower MPFA angle (77 vs 83) and higher Tonnis classification (1.58 verus 0.6). The mean Southwick angle was 29°. There was no association between the Southwick angle and the Tonnis classification.

Conclusion

At a mean of 17 years, patients with SCFE had impaired functional scores, a painful clinical examination for FAI and significantly more degenerative changes of the involved joint. Unstable hips had the highest risk for conversion to THA. Slip severity in terms of a lower MPFA angle and a slip beyond the anterior metaphysis, was associated with significantly more degenerative changes. Screw fixation should be reconsidered in the presence of these prognosticators for early osteoarthritis.

Poster: 43
#738

Bone Apposition of the Acetabular Rim in Deep Hips: A Distinct Finding of Global Pincer Impingement

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Hips with coxa profunda can present a pincer type impingement with linear impact between proximal femur and acetabulum leading with time to particular bone apposition on the acetabular rim. While in an endstage this bone formation is radiologically not anymore distinguishable from the native bone and the labrum may be more or less disappeared completely, the double line sign and the recess sign are suggestive for an ongoing process of such bone formation; the described phenotypes of bone apposition are indicative for the site of the impingement problem. Histology confirms that the labrum is rather displaced and superseded by the apposition than it is ossified itself. Morphological anomalies of the proximal femur such as a low neck-shaft angle or a short neck may further contribute to the mechanism of pincer impingement. While the bone apposition on the rim is first reactive to chronic impingement, its presence increases the impingement leading to further bone apposition. When symptomatic, the bony apposition should be trimmed, at least to the level of the native rim. The labrum should be preserved if enough substance can be isolated and technically refixed. The surgeon should anticipate for labral reconstruction with an allograft in case the labrum has become hypoplastic or even absent. The additional influence of femoral factors has to be carefully checked during surgery and eventually removed.

Poster: 44
#923

Early Results of the New GTS Uncemented Stem: Outcome of First Consecutive 570 Cases.

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INTRODUCTION

In January 2010 we began our experience with a new uncemented short stem. GTS is a throcanter sparing stem with a grit blasted titanium alloy and a tapered wedge geometry with full-surface fins.

MATHERIALS AND METHODS

In first 12 months 539 patients (570 hips, 31 bilateral) undergone a THA based on GTS: 282 males, 257 females, average age 57,8 years. Etiology: idiopathic 61%, F.A.I. related 21%, secondary 18% (41 DDH, 19 femoral head necrosis, 11 Perthes sequelae, 9 post- traumatic arthritis). Tribology: 306 ceramics on poly, 103 ceramics on ceramics, 81 metal on metal, 49 metal on poly. Standard 133° stem in 485 cases and varus 122° stem in 85 cases. We prospectically evaluated (clinically and radiographically) our patients with clinical and x-ray controls at 1, 3, 6 and 12 months.

RESULTS

Five cases of intra-op fracture occurred with the rasps (3 metallic wiring required). One traumatic fracture in the riabilitation period revised with a long stem and 3 cases of early septic complications without revision. In our radiographic analysis of implants with a 1 year minimum follow up (100 stems, 96 patients), we measured cervico-diaphyseal angle, flare index and cortico-medullary index on pre op x-rays and cervico-diaphyseal angle, metaphyseal filling rate and bone resorption signs on post op x-rays. We also evaluated legs length discrepancy and off-set reconstruction. The average pre-op C/D angle and off- set were 130.7 degrees and 51.0 mm. while post-op were 128.3 degrees and 50.23 mm. with a legs lenght discrepancy that ranges from 12.0 to 2.0 mm. We had no clinical or radiological signs of loosenings at follow-up.

DISCUSSION

Straight uncemented stems for THA show very good clinical and radiographic results but leave important questions open regarding bone and muscle sparing. Register data shows that demographic range gets wider and patient's activity level rises continuously.

CONCLUSIONS

Early clinical and radiographic follow up was comparable to our previous results with a straight uncemented standard stem. With new GTS stem we could appropriately reconstruct the pre-op morphotype and morphometry on a wide range of population without any increase in complications rate also without any patient selection.

Poster: 45
#926

An Easy and Safe Way to Match the Safe Zone in THA: The Femur First Tecnique

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Introduction

THA is a well known, safe and widely used procedure. Dislocation risk and post op ROM are closely related to component's position: it must be correct in static and dynamic situations to avoid impingement and improve tribology. We propose a method to closely and easily match the safe zone.

Materials and Methods

In January 2010 we began using our "femur first technique" in primary THA as a standard: postero-lateral approach to the hip joint; after femur exposure, osteotomy and preparation we leave planned/last rasp in situ; after acetabulum standard exposure, 2 mm. under- reaming to planned; hip reduction with a custom hemispherical solid plastic trial head, 1 mm. undersized to last reaming; limb positioned in neutral abduction and the knee 90° flexed, internally rotate the limb to make a 40° angle on the horizontal plan; mark acetabulum bony surface (anterior and posteriorly) along the plane defined by trial head's cut diameter; cup implantation respecting the bony mark and liner insertion; reduction with appropriate trial head for the liner, and definitive check of components reciprocal position. This way we performed 570 THA (31 bilateral) with a very wide tribology: 306 ceramics on poly, 103 ceramics on ceramics, 81 metal on metal, 80 metal on poly. We prospectically evaluated our hips with clinical and x-ray controls at 1, 3, 6 and 12 months.

Results

We do not observe any increase of intra or post operative complications in comparison with our previous data. We found a slight increase in average surgery time (from 54' to 63').

Discussion

The "safe zone" concept by Lewinnek (1978) requires a cup position with a range of 30°- 50°in vertical inclination and 5°-25°in anterior version. Muller was more restrictive about cup position and also recommends a 10°stem anteversion. Ranawat in 1991 introduced the concept of "reciprocally correct position" leading to a "combined anteversion" (sum of cup anteversion and stem antetorsion): suitable 45° for female and between 20° and 30° for male patients. Theoretical safe ROM is closely related to several factors: head-neck ratio leading to technical ROM(q), cup abduction(a), cup anteversion(b), femoral component neck angle(a), neck antetorsion(b). Yoshimine and Hisatome proposed some mathemathics formulas to match with: analyzing their graphics becomes clear that safe zone with 32 mm and bigger heads (in 45°cup abduction) is allways respected for a sum of femoral antetorsion and cup anteversion of 40°. The 40° line stands about in the middle of the safe area, between the critical values of 25° and 50°. With a more vertical cup, the safe zone is a little wider (15°- 45°), with the 35° line safely in the middle of the area.

Conclusions

In our experience the femur first technique is easy to perform, doesn't increase complications rate, slightly affect the surgery time and last but not least is very cheap. We need longer follow up, but our feeling is that our procedure gives a larger theoretical ROM, with reduction of edge loading or impingement and could be an important step to a durable arthroplasty.

Poster: 46
#775

Failure in Total Knee Arthroplasty Due to Fatigue Damage of Bone

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INTRODUCTION

Aseptic loosening of total knee arthroplasty components remains the most common complication. Subsidence is a major factor resulting in failure of the tibial tray due to malalignment, poor bone quality, or inadequate fixation. The objective of this study was to incorporate bone damage into patient-specific models of bone geometry and density to predict the effect of tibial tray alignment and bone quality on risk for postoperative subsidence.

METHODS

A finite element model was constructed in Abaqus v6.9 (Simulia, Dassault Systèmes, Providence, RI, USA). An algorithm to compute damage over multiple cycles was used based on creep strain and resultant damage. The elastic modulus was reduced to reflect the damage computed from the extrapolated creep using linear evolution from the strain at damage initiation to the strain at complete damage. This process of extrapolation was repeated until failure occurred or the desired number of cycles reached. A previously reported cadaver experiment was simulated (Wong J et al., JOR, 2011) in which four fresh-frozen human knees were implanted with a knee arthroplasty tibial tray (Triathlon CR, Stryker Orthopaedics, Mahwah, NJ, USA) on a multiaxial testing rig (Force 5, AMTI, Watertown, MA, USA) and subjected to up to 100,000 cycles of walking loads. Two tibial trays were tested in neutral and two in varus alignment. CT scans were used to generate specimen-specific FEA models. The initial local elastic modulus of the tibia was computed from qCT-derived bone density using MIMICS (Materialise, Leuven, Belgium). Micromotion between the tray and the bone was measured experimentally and used to assess failure.

RESULTS

A larger volume of bone was damaged when the tibial tray was aligned at 5° varus compared to the tray aligned perpendicular to the tibial axis. Failure was defined as greater than 1 mm subsidence of the tibial tray. The computational model predicted that both neutrally aligned cadaver specimens would survive more than 10 million cycles, while the varus aligned specimens survived 6 and 8 million cycles, respectively.

DISCUSSION

The subject-specific computational model of fatigue damage of bone was validated against experimental results and predicted earlier failure in knees implanted with tibial trays in varus. The progressive increase in the initial varus of the tray due to greater bone damage under the medial compartment was captured by incremental computation of cyclic creep and damage. Complete failure of local bone elements put adjacent elements at risk. The volume of damage expanded until tray subsidence reached a level that was clinically detectable. These results are also consistent with clinical radiostereometry analysis (RSA) reports (Ryd et al., JBJS, 1995). Models such as these will be extremely valuable in making patient-specific predictions of long-term clinical outcomes.

Poster: 47
#836

A Dual Mobility Hip Arthroplasty Design Reduces Risk for Hip Dislocation

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Introduction

Impingement between the femoral and acetabular components has been shown to be an important factor in dislocation, which remains a major complication in the short term. Several computer models have reported that hip range of motion is dependent on prosthetic design and component placement. However, none have incorporated the effect of variation in local bony anatomy and capsular restraints on dynamic dislocation.

Methods

Femoral and acetabular geometry was constructed after segmenting CT scans of hips (N = 9) in MIMICS (Materialise, Leuven, Belgium). CAD models of hip arthroplasty components were obtained from Stryker Orthopaedics (Mahwah, NJ) for the two acetabular designs: a current-generation liner locked in a shell (Trident X3 – denoted as Standard) with a 28mm head and a dual mobility head in a polished shell (Restoration ADM – denoted as ADM) with a 28mm internal bearing and a 46mm outside diameter polyethylene head. In the ADM design, the polyethylene liner is free to rotate between the head and the shell.

Components were virtually implanted in the 3D-CT reconstructed anatomic models using LifeMOD (LifeModeler, San Clemente, CA). Ligaments of the hip capsule were modeled as nonlinear springs. Contact was simulated between the head and the liner for both designs and between the liner and shell for the ADM design.

Results

Chair Rise: We simulated rising from a low chair, since this increases the risk for posterior dislocation. The hip flexion angle at impingement was significantly higher in the ADM design compared to the Standard design ($p = 0.002$). The ADM design also generated a higher moment resisting dislocation ($p < 0.001$).

Intraoperative stability test: To simulate a passive intra-operative stability test, the hip was placed in 100 degrees of flexion and 15 degrees of internal rotation and adducted until dislocation. The hip adduction angle at impingement was significantly higher in the ADM design compared to the Standard design ($p < 0.001$). The ADM design also generated a higher moment resisting dislocation ($p < 0.002$).

Discussion & Conclusion

The ADM design significantly reduced the potential risk for posterior dislocation in a high-risk activity by increasing flexion and generating a higher peak dislocation moment. These results also support the validity and clinical relevance of a passive intraoperative test commonly used by surgeons to assess stability. Two major factors of the ADM design, the mobile liner and the anatomic scallop in the anterior rim of the shell, increased the range of motion before impingement. Since the head remained stable in the mobile liner and the liner tends to subluxate during dislocation, it is the diameter of the mobile liner that affects the potential for dislocation as opposed to the diameter of the head in the standard design. Thus the liner in the ADM liner behaves as a true “large head” in the context of dislocation.

Poster: 48
#903

Effect of Anti-Gravity Treadmill on Knee Forces

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INTRODUCTION:

Peak tibial forces during various activities following TKA have been previously reported. These forces vary between 0.8 xBW (times bodyweight) while rowing, up to 4.5 xBW while jogging [1, 2]. These data have allowed surgeons to advise appropriate postoperative protocols to their patients for returning to full activity. Lower body positive pressure (LBPP) treadmill exercise is a new rehabilitation device that reduces the ground reaction forces and therefore joint forces. LBPP has no adverse impact on the cardiovascular system and minimal alterations of gait kinematics in orthopaedic patients [3]. This device is attractive during the periods of rehabilitation after knee surgery in which full weight-bearing is not indicated or not possible due to pain or weakness. How the reduction

in ground reaction forces translates to reduction in forces within the knee is not known. We directly measured in vivo tibiofemoral joint forces during LBPP exercise in order to validate the use of LBPP as an effective rehabilitation tool.

METHODS:

After appropriate IRB approval and consent, 4 subjects between 69 to 88 years of age (3 male, 1 female) with custom instrumented tibial prostheses were tested in the LBPP chamber. Each subject underwent a series of tests recording axial forces where sequential increase in the treadmill speed was accompanied by simultaneously decreasing the effective bodyweight. Knee forces and flexion angle were recorded as the treadmill speed increased incrementally from 1.5 to 4.5 mph at 1 mph intervals: for each speed the pressure was adjusted to decrease net bodyweight from 100%, to 75%, 50% and 25%. The knee forces were also recorded with the treadmill at 5° and 10° angles to simulate walking up and down an incline. Ground reaction force was measured via force plates in the treadmill. The data were normalized over a gait cycle averaged from at least 10 steps at each data point.

RESULTS:

None of the patients experienced any adverse effects during treadmill use. Using multiple linear regression, we were able to correlate the percentage reduction in bodyweight and treadmill speed with the peak knee force: peak knee force = –0.3 + 0.3 x speed + 1.89 xBW ($R^2 = 0.77$) (Fig. 1). While lower axial forces were recorded while walking down an incline, these were not statistically significant (Fig. 2).

DISCUSSION:

The treadmill was able to modulate knee forces from less than 1xBW to 5xBW by altering the pressure and treadmill speed. The high correlation using linear regression provides a convenient method for adjusting treadmill settings to generate the desired range of peak tibial forces. At 25% weight, the knee joint still recorded 0.8 xBW on average. This probably represents the effect of muscle activity on the tibiofemoral loads. Although the subjects reported increased difficulty while walking up inclines, the increase in axial tibial forces was not statistically significant. The LBPP treadmill allowed for a controlled decrease of the joint forces and might be an effective tool in the rehabilitation of patients following lower-extremity surgery.

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Figures

Poster: 49
#576

Does a Resurfaced Patella Experience Higher Vibrations Compared to the Non-Resurfaced Patella Following TKA?

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Resurfacing the patella was reported to reduce the patellofemoral contact area post-operatively, which leads to increased stresses in the polyethylene, and may decrease the longevity of the patellar implant. Therefore, some authors have suggested that the patella should be left non-resurfaced if possible. Other authors have argued that the natural patella is not well suited to articulate with the metal femoral component, and may quickly degenerate, imposing additional risks for the patient requiring a revision surgery. Therefore, resurfacing the patella during the TKA has been long debated in the literature and remains a controversial topic. We have recently developed a non-invasive method of studying the vibrations of the knee joint and the purpose of this study was to determine whether the resurfaced patella experiences different vibration patterns then non-resurfaced patella following the TKA. Since the patellar component is made of ultra high molecular weight polyethylene (UHMWPE), which

lacks the damping properties of the articular cartilage, our hypothesis was that the vibrations would be higher for the resurfaced patella. Higher vibrations might lead to loosening of the component and cause unpleasant sensations or even pain post-operatively.

A total of 45 Japanese subjects of both genders were recruited in this study; 28 having a resurfaced patella, and 17 having natural cartilage. The study has been approved by the IRB prior to data collection. All patients had JMM TKA implants. 5 Accelerometers were placed on the analyzed knee on the patella, medial and lateral femur, tibial tuberosity, and medial tibia. Each of the patients did a weight-bearing deep knee bend (DKB), and active, non weight bearing flexion-extension activities. Vibration signals were taken from the patella, bandpass filtered (80 to 2000 Hz), rectified and normalized. Next a number of statistical parameters were extracted for comparisons.

The mean and standard deviation were taken for each signal after being preprocessed. The resurfaced patella had a high and low mean of 4.24e-2 and 1.52e-3 respectively with a mean of 9.03e-3. The non-resurfaced patella had a high and low mean of 5.59e-2 and 1.84e-3 with a mean of 1.81e-2. An unpaired t-test revealed a p-value of 0.025. The high and low standard deviation of the resurfaced patella signals were 5.46e-2 and 1.00e-2 respectively with a mean of 2.79e-2. The high and low standard deviation of the non-resurfaced patella signals were 4.29e-2 and 8.32e-3 respectively with a mean of 1.75e-2. The p-value of an unpaired t-test for the standard deviation across the two groups was 0.011.

The present study has found that the resurfaced patella patients experienced larger vibrations during the weight-bearing DKB activity. In accordance with our hypothesis, the non-resurfaced patella had lower vibration magnitudes, which indicates a softer interaction than in the case of the resurfaced patella. The hard-on-hard surface interaction between the metal and polyethylene creates a greater vibration than that of the softer cartilage tissue on metal. The excessive vibration may conceivably contribute to loosening of the patellar implants, unpleasant sensations or even pain postoperatively.

Poster: 50
#639

Minimum 10 Year Follow Up of the Birmingham Hip Resurfacing – an Independent Series

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Introduction

Inferior survival of Total Hip Arthroplasty was reported in young adults. This led to the introduction of 3rd generation Metal-on-Metal-Hip-Resurfacing-Arthroplasty (MoMHRA). Long-term survivorship varying between 88.5 – 96% at 12 years was reported by designer centres. Arthroplasty Registries (AR) reported less favourable survivorships with female gender and size as negative factors. The aim of this study is to report the long-term survival and outcome of the Birmingham Hip Resurfacing (BHR) from an independent hip arthroplasty centre.

Methods

Since 1998, 1967 BHRs have been implanted in 1660 patients by a single independent surgeon. The first 149, implanted between 1999 and February 2001 were included in this study. The majority were male (97, 65%). Mean age at surgery was 50.6 years (range: 17 – 76), with primary OA as most common indication (120, 80%), followed by avascular necrosis (13, 9%) and hip dysplasia (10, 7%). Mean follow up was 10 years (0.1 (revision) to 12.6). Implant survival was established with revision as the end point. The Harris Hip Score (HHS) was assessed in all patients. Sub-analysis was performed by gender, diagnosis, femoral component size (Small: <50mm, Large: ≥ 50mm) and age at surgery (Young: <50yrs, Older: >50yrs).

Results

Of the 149 patients, 11 were deceased, 2 lost to follow-up, 8 revised and 128 still in-situ at minimum 10 years postoperatively. Failure modes included 3 pseudotumours, 2 loose femoral components, 1 fracture, 1 unexplained pain and 1 patient with painful impingement and high metal ions. The overall survival was 93.1% (95% CI: 88.3 -98.0) at 12 years. The mean HHS was 97 (63 – 100). Survivorship of the BHR in men was 99% (95% CI: 96.8 to 100.0%) at 12 years with one femoral revision for traumatic fracture at 1 month. Survivorship in women was

inferior to men (log rank= 0.001): 87.3% (95% CI: 76.2 – 96.6%) at 12 years. Seven revisions in 52 women (13.5%) were performed at a mean of 6.3 years (3.4-10.7). There was no difference in HHS between genders in the non-revised cases (p= 0.39) and no difference in survivorship with different pre-operative diagnosis (log-rank = 0.9) or between age groups (Young: 97% Vs Older: 93%, log rank: 0.34). There was a significant difference in 12-year survivorship between Small (86%) and Large components (99%) (log rank= 0.003). When adjusting for head size, the difference in revision rate between males and females remained significant (log-rank= 0.025).

Discussion

This is the first independent study reporting more than 10-years survival of MoMHRA and reflects an experienced hip surgeon's practice, including his learning curve of the procedure. The overall 12-year survival in these young adults was superior to registry reported figures of THA amongst young patients and corresponded well with previous reports from designer centres.

The long-term survivorship and clinical outcome of the BHR are excellent in men, uninfluenced by preoperative diagnosis or age. However, survivorship in women is significantly inferior and usually related to increased wear and reactions to metal debris. The results of this study support the use of MoMHRA with a good design.

Poster: 51
#642

The Role of Radiographs in the Diagnosis of a Problematic Hip Resurfacing

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INTRODUCTION

Metal-on-metal hip resurfacing arthroplasty (MoMHRA) has been a surgical option for the treatment of young patients with end-stage hip disease. Soft-tissue masses are increasingly reported around resurfaced hips and have been associated with high wear. Screening and diagnostic tools such as metal ion levels and cross-sectional imaging are advocated by regulatory bodies. However, orthopaedic surgeons traditionally rely upon radiographic features aiding diagnosis of a problematic hip arthroplasty. This retrospective study aims to investigate the value of radiographic assessment in predicting wear related problems in MoMHRA.

METHODS

Two independent centres included 400 patients with adequate radiographs, known clinical outcome and metal ions levels. Symptomatic patients or those with high ions and abnormal radiographs underwent further imaging (USS/ MRI). Patients with the finding of a pseudotumour(PT) on further imaging and intra-operatively formed the PT Group. All patients had radiographs evaluated by 3 surgeons for reactive lines, lucent lines, osteolysis, impingement signs, bone remodelling and resorption around the resurfaced hip. Radiographs were scored as being either Normal, Borderline (reactive line ± remodelled cortical bone following impingement) or Sinister (area of osteolysis ± lucent lines ± cortical resorption).

RESULTS

Positive radiological findings (Borderline or Sinister) were detected in 88 hips (22%), the majority being Sinister (48, 12%). For the whole cohort, the mean Cr/Co levels were 6.5 µg/ml (range: 0 – 146)/ 6.5 µg/ml (range: 1 – 119) respectively. There was a significant difference in ion levels between patients with normal X-ray findings (Cr: 4, SD: 10.6/ Co: 4.2, SD: 12.3), those with Borderline findings (Cr: 3.7, SD: 4.7/ Co: 3.5, SD: 4.7) and those with Sinister findings (Cr: 25.1, SD: 31.4/ Co: 23.1, SD: 29.7) ($p < 0.001$).There were 40 PTs detected in 11 males and 29 female patients with a mean follow-up of 42 months (range: 8-98). 31 of the pseudotumour hips (78%) had positive X-ray findings, 30 being in the Sinister Group and 1 in the Borderline Group. 35 of the PT patients had high ions. Only one patient of the PT group had low ions and no X-Ray findings. Amongst the 48 patients with Sinister findings, 30 were detected to have a PT, 14 had high ions, 2 had revision for a loose femoral component and 2 are under regular review and remain asymptomatic.

DISCUSSION

This study highlights the importance of X-ray changes in resurfaced hips for the presence of a PT or high wear. Although cross-sectional imaging is the gold-standard in the diagnosis of a PT, radiographic assessment provides valuable information; 78% of hips with PT had sinister changes while sinister changes and/or high ion levels were

seen in all but one PT patients. The risk ratio of a hip with sinister findings having high wear or a PT was 40. The presence of sinister findings had a specificity of 98% and a sensitivity of 57% in detecting hips with high wear or PT. However, surgeons should be aware that the absence of Sinister findings does not eliminate a PT and further investigations (ion levels, imaging) are indicated in symptomatic patients.

Poster: 52
#933

Intra- and Inter-Observer Variability of Jig Placement in Shape Match Technique of Total Knee Arthroplasty a Cadaver Study

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INTRODUCTION

Shape matching is a new surgical technique for total knee arthroplasty. For this technology to be effective, correct and reproducible placement of the customized, pre-manufactured jigs on the patients bone is essential. The current study aimed to evaluate intra-and interobserver variability of a shape match cutting guides in a cadaver study.

METHODS

A prospective series of 12 eviscerated human torso's were acquired for a total of 24 limb specimens that included intact pelvises, femoral heads, knees, and ankles. The cadavers received

an MRI, from which were manufactured the Shape Match cutting guides. Additionally all specimen received "pre-operative" CT-scans to determine leg axes. Knee joints were opened with a parapatellar approach and on each tibia and femur and on the cutting guides navigation trackers were mounted. Four surgeons placed the specific Cutting Guides six times each on all specimens. Positions of the Cutting Guides in relation to the Navigation trackers were recorded using a navigation system. For statistical analysis SAS was used and Cronbach alpha coefficient was applied. Cronbach Alpha tests whether or not measurements produce similar results.

RESULTS

Cronbach alpha was calculated to measure the internal consistency within surgeons. The results ranged from 80% to 100% for flexion, varus/valgus and rotation for the placement of the femur as well of the tibia jigs suggesting good to excellent reliability. The results for the inter-rater reliability ranged between 95%-98% as well on the femur as on the tibia regarding flexion, varus/valgus and rotation, indicating excellent reliability.

DISCUSSION AND CONCLUSION

Jigs placement of both the femoral as well as the tibial jig proved to be highly reproducible. With minimal resulting threedimensional deviation, this low inter- and intra observer variability indicates that the tested system can be safely used in order to transfer a MRI- based surface reconstruction to the individual patients anatomy.

Poster: 53
#537

Bone and Joint Implant Fixation Personalized

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Introduction

Although methods and devices for implant fixation continuously improve, an unacceptably high number of implant failures is typically due to loosening. The cut-out rate up to 8.3% has been recorded for hip screws [Born, 2010]. Furthermore, screws themselves can migrate and damage soft tissue [Hussain, 2010]. In a per-operative

approach, the surgical window can be limited and drilling access difficult. Moreover, certain areas of the human bone can pose high risks for damaging of adjacent neurovascular structures or internal organs.

Materials and methods

Methodology was developed to automatically derive patient-specific bone quality from CT-data. Overall bone quality for fixation purposes is based on overall bone thickness and local cortical bone thickness for bicortical fixation, as well as local bone density for spongious bone fixation. Hereby, screw positions and directions are pre-operatively planned either with customized or standard implants. Optimal screw traction and sustainable fixation are decisive for the location of a screw. Screw lengths for bi-cortical fixation can be assessed preoperatively, in order to avoid piercing vital soft tissues.

Based on the planned screws, a disposable custom jig is designed, specifically fitting onto the implant used. The device thereby establishes absolute directions and locations of screw pre-drill trajectories.

Results

A representative set of cases in the field of revision surgery and long bone trauma illustrate the added value of a personalized screw fixation. Four criteria are taken into account in the determination of the locations of the screws and the associated drill directions: (a) obtaining an optimal number of non-intersecting drill directions, (b) ensuring screw trajectories run through optimal bone quality, (c) ensuring optimal screw trajectory length; and (d) ensuring preservation of the surrounding healthy soft tissue. Pre-drilling of screw holes and consecutive screw placement is accurate up till 1mm and 1 degree average entry position and three dimensional angle variation respectively.

Conclusion

Personalized screw fixation allows accurate screw placement and safe application during surgery for more stable long-term outcome.

Poster: 54
#446

Assessing the Influence of Acetabular Cup Material on Pelvic Surface Strains After Hip Replacement Using Digital Image Correlation

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Introduction:

Acetabular cup loosening through increased bearing friction is a late failure mode of metal-on-metal hip resurfacings [1]. Periprosthetic bone deterioration may cause earlier loosening. Preserving supporting bone quality is a goal for implant design and materials selection; excessively stiff implants may alter the strain field in the supporting bone, potentially promoting loosening by stress shielding and bone resorption.

Advanced polymer and composite bearing materials, offering low wear articulation, have closer stiffness to bone tissue (E≈17GPa) than metals and ceramics and may promote less adverse bone adaptation. Computer simulations support this hypothesis [2,3], which this study aimed to evaluate experimentally.

Methodology:

A composite hemi-pelvis (Sawbone AB, Sweden) was reamed for a press-fitted, 58mm outer diameter, 52mm bearing diameter Cobalt Chromium (CoCr, E=197GPa) ADEPT cup (Finsbury Orthopaedics Ltd., UK). The hemi-pelvis was mounted on an Instron 8874 test machine (Instron Corp., USA), oriented so that the machine applied a 1500N load representing a generalised joint contact force, in 12° adduction (Fig.1).

Digital Image Correlation (DIC) was used for 3D surface strain measurement using twin digital cameras (Limess GmbH, Germany) and VIC3D Software (Correlated Solutions Inc., USA), by a previously verified technique. 5 datasets were collected to assess measurement variability. The test was repeated three times, with the hemi-pelvis:

intact, to obtain natural reference strains,

implanted with a 28mm diameter cemented UHMWPE cup (E≈0.9GPa), and

implanted with a 52mm diameter press-fitted MOTIS® CF-PEEK composite cup (carbon-fibre-reinforced PEEK, E=12-15GPa, Invibio Ltd., UK).

The strain in the implanted case was averaged across thirty-six 5mmx5mm gauge regions superior to the acetabular rim, and compared to the intact case to indicate the remodelling stimulus [4] for all three implant materials. Scatter graphs of implanted vs. natural strain were plotted, trend lines were fitted to the data, and the gradients were inspected to assess the average principal strain magnitude change. This allowed comparison of predicted bone responses to implantation with CoCr, UHMWPE and MOTIS cups.

Results and Discussion:

The average principal strain magnitude in the periacetabular cortical bone increased by 40% after implantation with a CoCr cup (R^2=0.84), and decreased by 24% after implantation with an UHMWPE cup (R^2=0.94). CF-PEEK produced the closest strain pattern to the natural case, increasing the average principal strain magnitude by 12% (R^2=0.91, Figs.2 and 3).

The results neglect residual strain from press fitting. Residual strains would be expected to relieve with time by adaptation and viscoelasticity, and to neglect them make the results a conservative estimate regarding the press-fitted cups. Interfacial micromotion was not studied, but requires further investigation.

Conclusion:

A MOTIS CF-PEEK acetabular cup was measured to produce the closest periacetabular cortical bone strain to the intact hip, in comparison to clinically used CoCr and UHWMPE cups. This provides experimental evidence to support previous computational studies indicating that cups produced using materials with stiffness closer to cortical bone may recreate physiological bone strains more closely, potentially offering improved longevity.

References:

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Figures

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Poster: 55
#499

Experimental Measurements and Numerical Predictions of Strain and Micromotion in Natural and Implanted Composite Hemi-Pelvises

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Introduction

Finite Element (FE) analysis is a useful tool to investigate implant-related failure mechanisms. To evaluate the quality of the numerical predictions, comparison with experimental measurements is necessary [1,2]. The objective of this study was to measure strain and implant-bone micromotions in intact and implanted composite hemi-pelvis models. These measurements were compared with the results predicted by equivalent FE models, to validate the FE models.

Materials and Methods

Two composite hemi-pelvis models (3405, Sawbones AG, Sweden) were tested. One was implanted with an acetabular component of 58mm outer diameter / 52mm bearing diameter (Finsbury Orthopedics Ltd., UK). Fixtures were used to hold the specimen at the sacroiliac joint and the pubis, in an orientation representing heel contact in a normal walking cycle (Fig. 1). Five rectangular strain rosettes were fixed at identical locations and orientations on both pelvises to facilitate comparison of principal strains. Three linear displacement sensors (Vishay Micro-Measurements, UK) were mounted to measure implant-bone micromotions in superior-inferior, anterior-posterior and medial-lateral directions (Fig. 1). The hip contact force was applied vertically through a 46mm diameter modular head attached to an Instron 8874 mechanical testing machine (Instron Ltd., UK).

FE models of the tested pelvis were developed, based on a CAD model obtained from the manufacturer. The models were meshed with ten-noded tetrahedral elements using ANSYSv11 software (ANSYS Inc., PA, Fig. 2). Isotropic material properties were used for the cancellous (E=155MPa), and cortical (E=16.7GPa) analogue materials. Contact elements, with friction coefficient 0.5 and 1mm press-fit at the edge of the acetabular cup, were simulated at the implant-bone interface. Frictionless contact was assumed between the femoral head and the cup. Applied loading and boundary conditions were equivalent to the experiment. Eight load cases with contact force between 700N and 1400N were chosen.

Results and Discussion

Compared to the natural pelvis, generally higher strains were recorded in the implanted case, indicating increased load transfer through the cortical shell. Reduced strain was observed in the proximal ilium, indicating possible strain shielding. Regression analysis indicated close agreement between the predicted and measured principal strains for both pelvises, with high correlation coefficient (0.92-0.97), low standard error of the estimate (37-39 me) and low error in regression slope (11-16%). Measured implant-bone micromotions were small (Fig. 3): 0-2μm (anterior-posterior direction), 0–30μm (medial-lateral direction), and 0–27μm (superior-inferior direction), whereas the FE predicted values were 0-4μm, 0-85μm and 0-51μm, respectively. While qualitative agreement between the measured and predicted micromotions, the quantitative mismatch observed may be primarily due to estimations of the interfacial press-fit and friction properties used in the FE model.

Conclusion

Good corroboration of principal strain values suggests the present model will serve as a suitable basis for strain assessment of the implanted pelvis. Reasonable correlations of micromotion values were evident and possible reasons for discrepancies have been identified.

References

[1] Dalstra M, et al. 1995, JBiomechEng 117.

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Figures

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Poster: 56
#655

Tibial Implant-Bone Micromotion Due to the Applications of Pure Torques for Different Tibia Designs

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Initial implant stability is an important factor for the success of cement-less total knee arteoplasty. To date, the effects of the moments to the initial stability of common tibial anchoring designs were not well studied. The purpose of this study was to investigate the tibial bone-implant micromotion under separated pure torque moments for a keeled and 3 peg tibial designs.

3D FEA models including left tibia bone obtained from virtual bone data and 2 tibial tray implants of 33mm long tri-flange stem-keel design and 12mm OD X 16mm long 3 peg design. The tibial implants were assembled in exact same orientation to two identical tibia bones with proximal plateau being virtually cut and prepared line to line interference fit for the stem-keel and pegs. The distal tibia was cut at 100mm from proximal plateau and was fully fixed. The two assembled models were imported into ANSYS Workbench v11.0. The Young's modulus (E) for the all cancellous tibia bone was 570 MPa and the Poisson's ratio (v) was 0.3. Both tibial trays were titanium alloy with 1.5mm undersurface CP titanium foam. The interfacial connections were: coefficient of friction was 0.4 for bone to stem-keel, pegs and titanium foam layer; bonding connections between titanium foams to solid trays and solid keel and pegs. The moments were applied to the local coordinate system located at the center of the tray based on the highest values reported by Heinlein et al as the stair descending activity: flexion moment M_{A-P} =24.920 N-M, the valgus-varus moment M_{L-M} = 20.94N-M and the external rotation moment M_{ER} = 8.9N-M. The body weight was 875N. The results were verified by simulating the physical testing of a keel tray implanted in the open cell saw bone (12.5 pcf foam, , E= 47.5MPa, ν=0.3) under pure rotational moment M_{ER}. The 8.9N-M torque was applied by a digital toque meter to the tibial tray. The micromotion was measured at lateral rim of the tray by a dial indicator.

The micromotion was obtained in the form of the sliding distance between contacting surfaces. The maximum micromotion for M-AP occurred in anterior spine of stem-keel and anterior peg. For M-ML, the maximum micromotion located at the lateral keel and lateral peg. The highest micromotion was under pure valgus-varus moment and the lowest was in external rotation for both designs. The stem-keel design had 46.9%, 44.3% and 21.6% reductions in micromotion from 3 peg design under valgus-varus, rotational and flexion moments respectively. The FEA results in maximum micromotion for the verification saw bone under pure external rotation was 0.276 mm which was higher than 0.036mm for the bone. The physical verification test revealed the average micromotion was 0.343mm (0.40mm, 0.38mm and 0.25mm) SD=0.0845.

The highest micromotion reduction occurred in valgus-varus moment for keel design. The length and grooves of tri-flange keel may have contributed to the higher resistance to the moments especially in the valgus-varus orientation. In the pure moment loading condition and without the compressive force, the implant-bone micromotion was magnified. The pure moment however is often applied intra-operatively to access tibial implant stability and it is an exaggerated worse case scenario to which these finding are relevant. The modulus of bone influenced the micromotion as the lower modulus of saw bone resulted in higher micromotion than cancellous bone.

Figures

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Poster: 57
#835

Accuracy of the Three Dimensional Planning for the Uncemented Tapered Wedge Femoral Stem

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Introduction:

Proximally coated tapered wedge femoral stems have demonstrated excellent long-term clinical results in uncemented total hip arthroplasty (THA) and have been one of the most widely used stem recently. The tapered wedge design helps to provide firm mediolateral stability within the femoral canal and reduced thickness in anteroposterior direction can preserve cancellous bone around the stem. On the other hands, because the stem is not designed to fill the femoral canal while achieving initial fixation, it can be positioned in any degree of anteversion. This might result in mal-anteversion of the stem or subsequent dislocation of THA. The purpose of this study was to evaluate how accurate we were able to insert tapered wedge stem with use of preoperative three dimensional (3D) planning.

Materials and Methods:

Forty consecutive patients who underwent uncemented total hip arthroplasty using a tapered wedge femoral stem (Accolade TMZF, Stryker Japan) were employed for this study. The average age of the patients at the time of surgery was 63.0 years (range, 43-81 years, 4 men and 36 women). Operation was done through the direct lateral approach in lateral decubitus position. We also implanted cementless hemispherical TriAD cups (Stryker Japan). Post-operative CT scans were performed and the stem anteversion angle were measured using 3D image-processing software (Stryker, Japan). The alignment of the stem in the coronal plane (varus or valgus) and sagittal plane (flexion or extension) were also measured. A CT based navigation system (Stryker Japan) was used for the purpose of measuring stem anteversion intraoperatively after implanting. Then, the difference between the pre-operative target angle and the angle measured from the post-operative CT was calculated as accuracy. The difference between the intra-operative and post-operative angle was also calculated.

Results:

The accuracy of preoperative planning (mean of the absolute difference between preoperative target angle and post-operative CT angle) for stem anteversion angle was 4.7 ± 3.4 degrees (range, 0-12 degrees). The accuracy of coronal alignment was 0.8 ± 0.8 degrees (range, 0-3 degrees), sagittal alignment was 1.5 ± 1.1 degrees (range, 0-4 degrees). On the other hand, the accuracy of intraoperative measurement using navigation system (mean of the absolute difference between intra-operative angle and post-operative CT angle) for stem anteversion angle was 2.7 ± 1.8 degrees (range, 0-5 degrees), which was significantly more accurate than that of preoperative planning ($p<0.05$).

Conclusions:

Our study showed that preoperative 3D planning achieved acceptable accuracy of anteversion in uncemented tapered wedge stem, however, we also experienced poor accuracy of the anteversion angle (more than 10 degrees) in some cases. Because the concept of “fit without fill in the femoral canal” has freedom to position the stem in wide range of anteversion angle, optimal preparation of femoral canal based on precise preoperative 3D planning and intraoperative assessment using navigation system is helpful.

Poster: 58
#574

Unusual Cause of Anterior Knee Pain; Primary Aneurysmal Bone Cyst of the Patella, Case Report and Literature Review

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The Aneurysmal Bone Cyst (ABC) is thought to be rare, its incidence is only 1-6% of all primary bone tumours and the Patella is affected in less than 1% of all cases of ABC. Pubmed search revealed only 15 reported cases.

We report a case of stage II primary aneurysmal bone cyst (ABC) of the right patella in a 22 years old man with up to 4 years clinical and radiological follow up.

Clinical examination, plain film radiographs and MRI scan established the presence of a primary aneurysmal bone cyst. The condition was treated by surgical curettage and autogenous bone grafting. Histopathology report confirmed the diagnosis and ruled out malignancy.

One year and three years follow up MRI scans detected chondromalacia Patellae with successful bone graft incorporation and no recurrence of the aneurysmal cyst. Arthroscopic debridement was performed for the chondromalacia patellae followed by physiotherapy and hydrotherapy. Four years postoperatively patient symptoms markedly improved with infrequent use of analgesic tablets.

This report is followed by literature review of the previous 15 published reports and a review of the current diagnostic and treatment practice.

Poster: 59
#573

Is There a Need for Routine Postoperative Surgical Follow Up Post Trapeziectomy or Single Digit Dupuytrens Fasciectomy in the Presence of Hand Therapist Follow Up?

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Introduction:

"No routine post-operative follow up appointments" policy has been implemented in NHS hospitals in different specialties for uncomplicated surgical procedures. In trauma and orthopaedics few studies to date reviewed this practice and reflected on the patients' opinions.

Methods:

In this study we prospectively surveyed 50 patients post simple Trapeziectomy and 71 patients post single digit Dupuytren's fasciectomy for their opinion of post operative care and whether they would have liked to be reviewed by the surgeon in a routine post operative follow up appointment or not. The total of 121 patients were recruited over 2 years for this study, each patient had post operative follow up by the hand therapist for 3 months.

All patients included in this study had their operations done by one surgeon in one hospital. All patients were reviewed by a hand therapist within 2 weeks post operatively and treatment protocols were followed with all the patients. During their final appointment with the hand therapist all patients completed a questionnaire survey.

Results:

116 patients completed the study, 5 post Dupuytren's fasciectomy patients were lost for follow up. 106 patients (91%) were satisfied with their post operative management and 99 patients (85%) did not want to be reviewed by the surgeon in a post operative outpatient follow up appointment.

Discussion:

This study reflects the successful application of "Hand therapy led follow up and discharge" policy with no routine post operative review by the surgeon in our organisation. We succeeded in reducing the waste in the NHS by avoiding at least 215 un-necessary routine follow up appointments over 2 years period. By applying this policy we also succeeded in avoiding the inconvenience to patients having multiple trips to the hospital. We advise implementing this practice for other common uncomplicated surgical procedures with possibility of giving the patient the option to request appointment with the surgeon if needed.

Poster: 60
#572

Standardised Transtibial ACL Reconstruction Technique Can Result in High Reproducibility Rate of the

Optimal Femoral Tunnel Position: Radiographic Review.

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The transtibial approach is widely used for femoral tunnel positioning in ACL reconstruction. Controversy exists over the superiority of this approach over others. Few studies reflected on the reproducibility rates of the femoral tunnel position in relation to the approach used.

We reviewed AP and Lat X-ray radiographs post isolated ACL reconstruction for 181 patients for femoral tunnel position, tibial tunnel position and graft inclination angle. All patients had their operations performed by one surgeon in one hospital between March 2006 and Sep 2010. All operations were performed using one standard technique using transtibial approach for femoral tunnel positioning.

Two orthopaedic fellows, with similar experiences, reviewed blinded radiographs. A second reading was done 8 weeks later. Pearson intra-observer, Intraclass inter-observer correlations and Bland-ALtman agreement plots were analysed using SPSS 19.

Mean age was 33 years (range 16 – 54), Pearson intra-observer correlation shows substantial to perfect agreement while Intraclass inter-observer correlation shows moderate to substantial agreement. Bland-Altman agreement plots shows substantial agreements.

Previous literature proved that optimal femoral tunnel position for the best clinical and biomechanical outcome is for the centre of the femoral tunnel to be at 43% from the lateral end of the width of the femoral condyles on the AP view and at 86% from the anterior end of the Blumensaat's line on the lateral view. In our study the mean of femoral tunnel position in AP view was 42% with SD 3%, while the mean for the tunnel position on lateral view was 81% with SD 10%.

85% of the femoral tunnels were within +/- 5% of the optimal tunnel position on the AP views (43%), and more than 70% of the femoral tunnels were within +/-5% of the optimal tunnel position on the Lateral view (86%).

Based on our results we concluded that using one standardised transtibial technique for ACL reconstruction can result in high reproducibility rates of optimal femoral tunnel position. Further studies are needed to validate our results and to study the reproducibility rates for different approaches and techniques.

Poster: 61
#1097

Strain Response of an Instrumented Intramedullary Nail to Three-Point Bending

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Background and Aims:

The purpose of this study was to undertake a biomechanical evaluation of a first generation (Gen. 1.) instrumented Trigen Meta-Nail (Smith&Nephew®). Our objectives were: 1) Identify the most sensitive strain gauge pocket out of the eight available, and 2) Prove that the nail is able to detect changes in stiffness of the nail-bone composite. The ultimate purpose of this instrumented nail is to objectively and directly quantify fracture healing to enable prediction of delayed or non-union two months faster then existing methods

Methods:

A 3-point loading mechanical setup was selected as the most clinically relevant. The instrumented nail was inserted

into 4th generation Sawbones® of 3 different fracture configurations as well as a non-fractured bone. The nail bone composite was loaded at five separate positions to determine the strain changes in each of the eight strain gauge pockets. To simulate callus in the simplest possible way and increase the stiffness of the nail-bone composite, loops of duct tape in multiples of four were applied over the fracture locus. The 3-point loading jig was used to obtain the change in strain count with increasing stiffness. Stiffness was quantified using radiostereometric analysis (RSA).

Results:

There was no single position of greatest strain gauge pocket sensitivity for all fracture types. The highest change in strain count occurred when the strain gauge pocket and fracture line were in maximal proximity. Applying the loading moment over the strain gauge pocket also maximised its sensitivity. The duct tape "callus" simulation has shown that the instrumented nail was able to detect a change in stiffness of at least 4.1Nm/°.

Conclusions:

The original findings of this study include a qualitative description of the crucial relationship between strain gauge position and fracture locus. This will enable the formulation of a compensating algorithm for gauges positioned remotely to the fracture. Quantitatively, we have shown that the instrumented nail detects physiologically relevant changes in stiffness. This supports the instrumented nail's ultimate objective.

Figures

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Poster: 62
#716

Wrist Kinematic Behavior Correlation With Funcional Outcomes and Progress in Patients Having a Total Wrist Arthroplasty

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Purpose:

Total wrist arthroplasty cannot mimic the multifaceted mechanics of the normal wrist which involves several articulations among the radius, ulna, and carpal bones. Instead of this the prosthesis tries to provide the same biomechanics. The purpose of this study was to examine how wrist range of motion and grip strength is influenced by replacing wrist joint prosthetically in contrast with rheumatoid and normal wrists. Circumduction tasks were also chosen to quantify wrist mobility because circumduction better quantifies wrist mobility than does isolated flexion/extension or radial/ulnar deviation. Two patient-reported questionnaires available for assessing hand and wrist function were included in this study: Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire and Patient-Rated Wrist Evaluation (PRWE). These surveys have been validated as appropriate tools for subjectively measuring hand and wrist functionality and pain.

Materials and Methods:

20 women and 2 men (27 prosthetic wrists) with a mean age of 55 years from Hospital de Santo António, Porto, Portugal participated in this study. All patients had rheumatoid arthritis, and each one had a Re-Motion or Universal II prosthesis with a mean follow-up of 20.8 months (range: 2-58.5 months). Wrist joint range of motion was measured on both patients's hand with a universal goniometer, and a standard, adjustable-handle Jamar® dynamometer was used to measure grip strength. A simple, affordable circumduction measurement tool was developed based on Charles Day et al. was used to get the functional range of motion (ROM) of the wrists.

Results:

Patients with a follow-up between 1-6 months reached 59.4N; patients with 6-24 months reached 93.2; and patients with a follow-up above 24 months reached 98.8N of grip strength. Patients with 6-24 months exhibited larger wrist movement patterns in both planes with 21.8°, 44.2°, 23.2° and 9.0° for flexion, extension, ulnar and radial deviations, respectively. It was this group of patients that reached the lowest values of circumductive motion and also they were the most satistied patients in terms of ability and pain relief. Patients with a Re-Motion prosthesis showed better performances than those with Universal II. Groups with higher follow-up time showed better ROM and grip strength but worse ability for full circumduction when compared to rheumatoid wrists.

Conclusions:

A large number of positive and negative factors can affect the range of motion, grip and pinch strength and circumductive motion measurements. However, we could say that, although all patients were able to perform tasks of daily life, there was no negligible decrease of grip strength. Also, performance seems to be influenced by the prosthesis.

Poster: 63
#415

A Rationale for DVT/PE Prophylaxis Following THR/TKR: Balancing Clots and Bleeds

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A Rationale for DVT/PE Prophylaxis following THR/TKR: Balancing Clots vs. Bleeds

Joseph F. Fetto MD

DVT/PE prophylaxis has remained a controversial topic, particularly as it relates to THR/TKR.

Historically there has been a concentration of attention on the prevention of TE phenomenon. However this focus has neglected to address those patients who tend towards the hemophyllic end of the coagulation spectrum. It has been reported that bleeding/wound complications following an arthroplasty can represent as great or even greater cost to the healthcare system, and more importantly greater consequences to the patient, than a DVT or even a non-fatal PE.

We have endeavored to initiate an inexpensive, pre-operative screening protocol with which to stratify patient risk for both TE and potential wound complications due to anti-coagulation prophylaxis. In addition to present risk stratifying tools, i.e. history, it includes specific hematologic and ultra-sonograhic evaluation. This pre-operative protocol has outlined a cost savings program. This program provides objective data with which to determine the prophylaxis to be administered to a given patient. As well, it has served to optimize the risk/benefit /cost of treatment rendered. It has proven to be effective in the reduction of TE events (DVT 6%) as well as associated wound complications and re-admissions. It is also in compliance with present regulatory mandates imposed by CMS, SCIP and other governing agencies.

Poster: 64
#607

Differently Used Acetabular Reamers Can Compromise the Primary Stability of Press-Fit Acetabular Cups in Ex-Vivo Pull-Out Tests

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Approximately 1,000,000 total hip replacements (THR) are carried out worldwide every year. The main reason for implant revision with 75 % of all cases is aseptic loosening which can be caused by stress shielding or wear

particle induced osteolysis. The latter originates from micro motions at the implant-bone interface which can be high especially if primary implant stability is poor. Furthermore, osseous implant integration will not take place if micro motions exceed approximately 150 μm. Hence, it is important to achieve a high primary stability to enable good secondary implant stability in THR. Reaming of the acetabular cavity could play a key role in primary stability. Therefore, the aim of this study was to correlate the size of differently used acetabular reamers and the cavities milled concerning the primary stability of two press-fit acetabular cups in standardised ex-vivo tests.

In total six reamers, three new and three used (over 2 years of surgical application) conventional reamers of size 56 mm were used for the investigations. To simulate worst case conditions, PMI blocks (polymethacrylimide, ROHACELL® 110 IG, Gaugler & Lutz OHG, Germany) with low density (110 kg/m³) were deployed to mill cavities with the provided acetabular reamers mounted on a table drilling machine. The reamers as well as the cavities were scanned using a 3D laser scanner (3D Digitizer Minolta VIVID 9i, Konica Minolta Sensing, Japan) to constitute linked 3D polygon models. Subsequently, the dimensions of the reamers and cavities were determined using PolyWorks® (InnovMetric Software Inc., Canada). Furthermore, two commercially available press-fit acetabular cups, Trident PSL® (Stryker, Germany) and EP-Fit Plus® (Plus Orthopedics, Switzerland) were inserted into the cavities in an impact-like manner using a dynamic testing machine (Instron 8874, Instron, Germany). Finally, the primary stability of the hip cups was determined by means of pull-out tests using a universal testing machine (Z050, Zwick/Roell, Germany).

An average maximum diameter of 56.1 and 55.9 mm was obtained for the new and used reamers respectively. Reamed cavities measured an average diameter of 55.3 and 55.6 mm for the new and used acetabular reamers respectively. Pull-out forces of the Trident PSL® and EP-Fit Plus® cups out of cavities milled by new reamers averaged 1024 and 1058 N respectively. Considering the cavities of the used reamers the pull-out forces varied between the Trident PSL® and EP-Fit Plus® cups significantly averaging 872 and 997 N respectively.

A significant difference in maximum diameter between new and used reamers could not be observed. However, a small increase of 0.3 mm in diameter was assessed for cavities milled by used acetabular reamers which reduced the pull-out force, and hence the primary stability of the Trident PSL®. Nonetheless, diametric enlargement of the acetabular cavity did not affect the primary stability of the EP-Fit Plus® significantly, which indicates an implant design dependency. To minimize primary stability reduction in THR, cavities should be milled as accurately as possible. Futher investigations will analyse differences in cavity diameter reamed by different surgeons and its effect on the primary stability of press-fit acetabular cups.

Poster: 65
#1135

Biomechanical Investigations of Joint Kinematics and Stability of Unconstrained Total Knee Replacements

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Postoperative instability of total knee replacements (TKRs) remains one of the most prevalent complications. In this context, many researchers refer to multiple influencing factors, such as inadequate implant design and positioning, ligament insufficiency or imbalance. However, the actual event of instability involving complex interactions between implant components and soft tissue structures is not well understood. The purpose of this work was to enable investigations of unconstrained TKRs with respect to kinematics and stability of the artificial joint under biomechanical circumstances by means of a hardware-in-the-loop (HiL) simulation.

The HiL simulation involves two units. On the one hand, there is a multibody model composed of all relevant body segments of the lower right extremity including hip, tibiofemoral, patellofemoral and ankle joint modeled as

ideal joints. Ligament structures of the tibiofemoral and patellofemoral joints, such as cruciate and collateral ligaments, are represented as nonlinear spring-damper combinations following force-displacement characteristics derived from in vitro measurements. Moreover, the quadriceps muscles are modeled as Hill-type muscle elements whereas only passive muscle forces are considered within this work. On the other hand, there is a physical test setup composed of an industrial robot equipped with a force-torque sensor at the endeffector, and a compliant support. The femoral component is attached to the endeffector whereas the tibial component is fixed on the compliant support. According to the movement angles and reaction forces/torques provided by the musculoskeletal model, the robot rotates and loads the femoral component with respect to the tibial component. The resulting position and loading of the femoral component are measured and fed back into the model, thus, closing the control loop for the HiL simulation.

A passive flexion movement of a bicondylar unconstrained TKR (Multigen Plus knee, Lima Lto, San Daniele, Italy) was simulated with two different conditions of the anterior cruciate ligament (ACL) implemented into the multibody model: with and without all ACL bundles. Normally, all ACL bundles are resected during implantation of bicondylar TKRs. The considered load case emulated a postoperative passive mobilization of the knee joint by a physical therapist without muscle activity.

The HiL simulation was carried out for both conditions of the ACL from 0° to 90° flexion at constant internal/external rotation of 0° (Fig. 1). Due to the interdependency between measured displacements/rotation and calculated reaction forces/torques by the elongation of ligaments, the different conditions of the ACL resulted into different outcomes of the relative displacement of the femoral component with respect to the tibial liner. Considering anterior-posterior translation, the femoral component tended to shift anteriorly at low flexion angles (below 20°) when the ACL bundles were incorporated. Contrarily, the femoral component shifted only posteriorly when all ACL bundles were taken out. As a result, it could be shown that change in ligament structures altered the load situation and thus the kinematics of the considered unconstrained TKR within the HiL simulation. In further studies active muscle forces will be taken into account in order to evaluate the impact of restraining ligaments, implant positioning and design parameters.

Poster: 66
#1040

The Evaluation of Anteversion Angle of Stem in Total Hip Arthroplasty With Ct-Based Navigation System

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(Objectives)

Anteversion angle of the stem in total hip arthroplasty (THA) is important for avoiding the impingement with the edge of cup. It is difficult to decide the correct angle of the stem with two-dimensional pre-operative planning in THA. So we use CT-based navigation system for making correct three-dimensional pre-operative planning about the angle and the position of stem. We evaluated the accuracy of pre-operative planning by comparing with post-operative CT data.

(Materials and Methods)

We treated 60 hips in 59 patients (9 male and 50 females) by navigated THA. 54 osteoarthritis hips, 4 rheumatoid arthritis hips and 2 femoral neck fractures were performed THA with VectorVision Hip 2.5.1 navigation system (BrainLAB). Implants were AMS HA cups and PerFix stems (Japan Medical Materials, Osaka). Appropriate angles and positions of stems were decided on the 3D model of hip joint before operation. According to the preoperative planning, we put the cups with navigation system and stems without navigation system. We measured the anteversion angle with post-operative CT data and 3-dimensional template software.

(Results)

The average angle of stem was 31.2 degrees (5-50 degrees) in pre-operative planning. The average angle was 25.7

degrees (0-50 degrees) in post-operative CT data. We calculated the deference between the anteversion angle of panning and the angle of post-operative CT data. The average of former was 6 degrees (0-24) bigger than latter. 45 hips (75%) were tend to decrease the anteversion angle in post-operative CT data.

(Conclusions)

Anteversion angle of stem depends on the shape of proximal femur. It is important to decide the angle of the cup for avoiding the impingement with the edge of cup. Most cases tend to decrease the anteversion angle in post-operative CT rather than pre-operative planning. We perform THA by direct lateral approach (modified Hardinge's approach) and the stem tend to insert from relative anterior direction with this approach. The anterior cortex of proximal femur is cause to decrease the anteversion angle by interference to anterior aspect of stem.

Poster: 67
#461

The Estimation of the Floor Reacting Force by Motion Analysis

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The objective of this study was to estimate the floor forces without force plates. Floor force is the important parameter in motion analysis and is necessary to introduce muscle forces of lower limb or knee joint forces. However, setting force plates is so troublesome that the floor force could be measured only in the room with force plates. If floor forces could be estimated by motion analysis, we can introduce floor forces anywhere with video camera.

We supposed that the forces acting the whole body were gravity force, inertia force and floor forces. Then the floor force was introduced by force equilibrium condition on the body. The gravity force might be the mass of whole body and could be measured. In order to introduce inertia force, the body was modeled as the linkage mechanism of foot, calf, thigh and upper body. Then tracking the center of gravity of the links, the inertia forces could be introduced from the acceleration and the mass.

The motion to be analyzed was the ascending from a squatting position. The subject was healthy male, age of 22years, height of 1.75m and weight of 53kg. We also used the force plate and measured the floor forces to compare the values of the measured forces and the estimated forces.

The results are shown in Fig.1. Character X and Z stand for the floor forces of horizontal and vertical components, and solid line and dashed line mean the estimated and measured values respectively. The estimated forces varied widely by comparison with measured forces. It might be occurred from a measurement error of the joint angles, especially the angles of the ankle joint, because the length of the foot was so short that it was difficult to measure the angle accurately. Then we introduced the knee joint forces using the estimated and measured floor forces. The results from each value were in well agreement. As a future subject, we are planning to produce the software to measure the joint angles using just pictures from a video camera.

Figures

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Figure 1

Poster: 68
#600

Mini-Incision Total Hip Arthroplasty by Modified Watson-Jones Approach Using New Double Offset Broach Handle and Partial Femoral Reamer

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[Introduction]

Recently total hip arthroplasty (THA) was performed by mini incision technique. Many surgical approaches were reported in the world. We designed and produced the new double offset broach handle and short partial femoral reamer to reduce the complication during and after surgery at 2nd series in this study. The purpose of study was to examine the short term results for mini-incision modified Watson-Jones approach.

[Methods]

Mini-incision, muscle sparing, anterolateral modified Watson-Jones approach for THA were performed 225 osteoarthritis patients according to the group I and group II by the Crowe classification between April 2006 and March 2011. 33 patients were male and 192 patients were female. Average age at operation was 64 years old and average body mass index was 23.3. About Surgical time, total blood loss, acetabular cup position angle of anteversion and inclination, complication during surgery and after operation were examined at the compared the first 75 patients (1st series) with the last 150 patients (2nd series).

[Results]

At 1st series, operative time averaged 106 minutes (range 75-155 minutes), blood loss was 693ml, average cup anteversion was 19.8°, and inclination was 44.3°. There were six complications, including one deep infection, three intraoperative proximal femoral fractures, three postoperative greater trochanter fractures. At recent 2nd series, operative time averaged 81 minutes (range 47-150 minutes), blood loss was 535ml, average cup anteversion was 15.9°, and inclination was 41.8°. There were only two complications, including one deep infection and one intraoperative calcar fracture. No patients sustained hip dislocation and pulmonary infarction.

[Discussion and conclusion]

Mini incision modified Watson-Jones approach was widely spread for minimal invasive total hip arthroplasty. But recently some surgical errors and complications after operation were reported. At our experience five complications except for deep infection were occurred at 1st series because of surgical errors, but at 2nd series, surgical errors were mostly reduced to learn safety and correct surgical skills. At that time, we designed new double offset, high offset broach handle and short partial femoral reamer. These surgical instruments were provided helpfully and safety operation for mini incision modified Watson-Jones approach.

Poster: 69
#532

Multi-Pelvis Characterisation of Articular Cartilage Geometry - Comparison With an Analogue Model

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Introduction:

The acetabular cartilage plays an important role in lubrication and low friction articulation of the hip joint [1]. Mechanical forces influence the structure of the articular cartilage [2] and underlying bone, so the acetabulum takes a horseshoe form with the central and inferior part (acetabular fossa) remaining uncovered. To analyse the function of the hip, and to test prosthesis designs which aim to load the bone in a physiological manner, a physiologically representative model of the acetabulum is required.

Artificial analogue bone models are available for mechanical testing of the performance of the hip. These are readily available, cost-effective, and attempt to replicate the properties of bone using representative stiffness materials. However, these models are deterministic, modelling one particular bone geometry. The purpose of this

study was to look at variability in acetabulum geometry in dry skeletons, and to determine where the geometry of the analogue model fits within the measured range.

Methodology:

i) Negative casts were taken from 3 dry natural pelvises (Gubener Plastinate GmbH,Germany) which were digitally scanned (Taicaan,UK) to produce surface point clouds. A MATLAB nonlinear least-squares algorithm was used to fit a sphere to the bearing surface [3], giving the bearing diameter.

ii) For a further 9 hemi-pelvises (part of full skeletons, for which moulds were impractical), and 1 analogue hemi-pelvis (Sawbone AB,Sweden), the acetabulum was photographed normal to its rim. A circle was fitted to the acetabular rim outline using ImageJ (National Institutes of Health,USA), allowing the bearing diameters of all 13 acetabulums to be estimated from their rim diameters. A circular disc was placed in the acetabulum normal to the acetabular rim, indicating the bearing surface centre.

iii) The cartilage internal geometry was characterised using ImageJ. Height and average width measurements were taken from the outline of the acetabular notch (Fig1). The mean and standard deviation (SD) notch width and height was calculated. Scatter graphs of bearing diameter vs. notch height and width were plotted.

Results and Discussion:

The mean bearing diameter was 50.77mm (SD:3.65mm). The mean notch height was 31.95mm (SD: 6.24mm). The mean notch width was 22.47mm (SD:2.80mm). Trendlines were fitted to the diameter-notch height and diameter-notch width charts, but no clear trends were visible (R^2<0.5, Fig2). The Sawbone diameter was 54.64mm, 1.06 SDs above the anatomically measured mean. Its notch height was 32.83mm, 0.14 SDs above the measured mean, and its average notch width was 25.84mm, 1.20 SDs above the measured mean.

Within the data set analysed, the Sawbone bearing diameter falls into the 88th percentile (Fig3a), the width into the 85th percentile (Fig3b) and height into the 56th percentile (Fig3c) of the natural pelvis population. Consequently, height was small for its bearing size compared to the measured data, but within the natural distribution.

This study supports the Sawbone geometry as a representative generalised test case for biomechanical studies; further analyses would strengthen the distribution plots, and confirm the relationship between the Sawbone model and the natural pelvis.

References:

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[2] Arokoski et.al,2000 ScandJMedSciSports

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Figures

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Figure 1 HYPERLINK "http://app.istaonline.org/figures/545.jpg" \t "_blank"
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Figure 3

Poster: 70
#628

Development of Artificial Hip Joint Inserting a Garter Spring as an Impact Relief Device

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Development of Artificial Hip Joint Using an Inserted Garter Spring as an Impact Relief Device

Artificial joints have been increasingly used in the treatment of physically disabled people who suffer from joint diseases such as osteoarthritis and rheumatoid arthritis. Ultra high molecular weight polyethylene (UHMWPE) is commonly used in hard-on-polymer joints as an impact-absorbing material for artificial hip joints because of its very low friction coefficient, high wear residence, impact strength, and biocompatibility. However, the polyethylene wear particles generated by excessive wear and fatigue can cause osteolysis, which may lead to loosening. This has led to recent interest in metal-on-metal joints, which can provide better wear properties than hard-on-polymer joints, leading to reduced osteolysis. However, during gait, metal-on-metal joints are exposed to greater impacts than those with hard-on-polymer joints. These impacts cause severe pain to patients who undergo hip replacement arthroplasty.

In previous work, we described a novel metal-on-metal hip joint with a coil spring impact relief device inserted between the Co-Cr-Mo alloy liner and the acetabular shell, which was able to reduce the impact load. However, our proposed joint had several problems. First, it suffered from a lower anti-dislocation property than traditional metal-on-metal joints, due to restricted mobility of the joint as a result of the impact relief device. In addition, production costs for the joint were higher due to the complex impact relief mechanism.

In this paper, we propose a revised metal-on-metal artificial hip joint in which a garter spring replaces the coil spring in the impact relief device, as shown in Fig. 1. Results show a marked improvement over the earlier coil device. In the case of a coil spring, contraction of the spring reduces impact loading. In contrast, with a garter spring, contraction increases the pitch angle, which may lead to a reduction in impact load. Hence, the housing volume for the garter spring impact relief device can be much smaller. Also, the allowable load in the direction of the vertical axis is larger for the garter spring than the coil spring.

Static compression tests using a conventional vise were conducted to examine the deformation of various garter springs under uniaxial loading. Also, garter springs with varying pitch angles were investigated, and the maximum applied load was determined by taking into account the applied load on actual hip joints.

Results showed that deformation of garter springs under uniaxial loading increased in proportion to the pitch angle. Results also showed that the hip joint proposed here would provide a simpler mechanism for impact relief devices leading to reduced manufacturing costs.

Figures

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Figure 2

Poster: 71

#930

Evaluation of Eccentric Femoral Broaching in Primary Hip Arthroplasty by Medulloscopy

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Background:

In primary hip arthroplasty little work has specifically addressed how bone preparation can be optimized on the femoral side. Eccentric broaching compromises the cement mantle, positioning of the femoral component and can even lead to perforation or fracture. In the present study we investigated the value of medulloscopy in improving the accuracy of femoral broaching.

Methods:

We prospectively evaluated the results of 75 primary hip arthroplasties that were medulloscopically assisted by a standard 10mm laparoscope. The extent of eccentric broaching was standardized on a four point scale. The results of the 3 series of 25 consecutive femoral canal preparations were compared. Statistical analysis was done by means of a non-parametric ANOVA.

Results:

In the beginning of the study there were 2 grade C (8 percent), 12 grade B (48 percent) and 11 grade A (44 percent) femoral canal preparations. However this declined to no grade C, only 6 grade B (24 percent) and 19

grade A (76 percent). A significant difference between the first series of 25 femoral canal preparations and the following 2 series ($p<0.05$) could be demonstrated. No statistical difference could be found comparing the second and third series.

Discussion:

We could demonstrate an important improvement of the quality of canal preparation with the use of medulloscopy. In our experience the learning curve is rather small. Therefore medulloscopy of the femoral canal is an easy and effective tool for quality control in primary hip arthroplasty.

We studied the use of medulloscopy to improve femoral canal preparation. Our data demonstrate a significant improvement of the quality of canal preparation with a relative small learning curve.

Poster: 72
#932

Conversion of Tantalum Rods to Resurfacing Hip Arthroplasty

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The use of a porous Tantalum implant has been introduced for the treatment of early stage osteonecrosis of the femoral head. We address the conversion of failed Tantalum rods to resurfacing hip arthroplasty leaving the tantalum rods in place in 6 patients. All patients were reviewed after 3 years. There were no revisions to total hip arthroplasty. The indications and the surgical technique of this procedure are described while offering the orthopaedic surgeon guidelines to perform a successful conversion.

Key words: femoral head osteonecrosis, Tantalum rod, conversion, resurfacing hip arthroplasty

Poster: 73
#592

Ligament Balancing in Posterior Stabilized TKA Using a Tensor Device With Load Sensors

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Component positioning in total knee arthroplasty (TKA) has an important influence on ligament balancing, stability, function and ultimately the long-term survival of the implant. Flexion balance, which depends on femoral rotation, is the most difficult to be evaluated intra-operatively. Rotational malalignment of the femoral component is one the major cause of postoperative complications in modern total knee arthroplasty resulting in instability, pain and stiffness.

80 consecutive total knee arthroplasties, including varus and valgus deformities were studied and have been evaluated post operatively with full leg standing X-rays and CT scan.

After making the extension cuts and balancing the extension gap, we used a ligament tensioning device with digital pressure sensors to objectively measure the pressure generated in both the medial and lateral compartment in flexion with the patella in place. Using a special torque, mechanically measured, femoral component rotation is modified until achieving both compartments pressure equilibrium. A mathematical model was validated using all these data.

This device permits the surgeon to achieve a perfectly balanced knee in flexion based on objective intra-operative measurements.

Keywords: ligament balance, posterior stabilized total knee arthroplasty, pressure sensor, distraction force, components rotation.

Poster: 74
#562

Mathematical Model Suggested for the Study of the Knee Mechanics

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Balance and stability of the knee are important for the life time of total knee prostheses. Knowledge of the biomechanical behavior of total knee arthroplasty is required. A mathematical model was proposed and tested on a statistically significant group of total knee arthroplasties using a ligament tensioning device with pressure sensor and a torque drive. During the operation we determined the relationship torque / angle of deviation between tibia and femur. Statistical analysis confirmed the data as a very good mathematical model. It can be used to describe the surgical gestures, the different ligament tensioning devices and to predict the behavior of knee after surgery. Also, this model could help to improve the currents tensioning devices.

Poster: 75
#966

Surgical Approaches to the Hip Joint in Total Hip Arthroplasty

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Introduction

Total hip arthroplasty (THA) is one of the most common orthopaedic procedures in the developed world, with one of the highest rates of post-operative complication. The numerous surgical approaches to THA share the same aims; to minimise pain and optimise limb function. However, currently no definitive opinion exists as to which surgical approach is most successful, due to a lack of reliable studies and inconsistency of outcome measures.

The aim of the study was to evaluate the anatomical complexity and post-operative complications of three classic approaches to total hip arthroplasty (THA); posterior, lateral and anterior.

Methods

The paper involves both anatomical study and the analysis of published data. Three cadaveric specimens were dissected, exploring the anatomy of the hip region encountered upon each surgical approach and evaluating its complexity. Each approach was then considered by means of literature review with regards to their post-operative complications, including superior gluteal nerve (SGN) damage, sciatic nerve (SN) damage, post-operative limp and post-operative dislocation.

Results

The study revealed each approach to have distinctly different benefits and risks.. The anterior approach with osteotomy minimises the risk of post-operative abductor dysfunction by maintenance of the gluteal muscle attachments. Lateral approach is a less grossly traumatic procedure, but affords less visual exposure of the surgical field leading to potential SGN damage. Posterior approach risks both SGN damage and post-operative dislocation, but affords good exposure of the acetabulum. The literature is difficult to directly compare as the varying risks of each approach lead to the use of different outcome measures.

Conclusion

Ultimately the question of which approach should take precedence remains. Each option has both advantages and risks, with selection usually dictated by case suitability and the surgeon's training. This conclusion and existing studies highlight the need for further more standardised investigations using outcome measures applicable to all approaches, such as quality of life scores, in order to identify whether a best approach can ever exist for optimum patient outcome. Minimally invasive approaches to THA may become commonplace in standard care long before this question is suitably answered.

Poster: 76
#945

Validating an Inertia-Sensor Based Gait Test and Motion Parameters for Functional Outcome Scoring in

Routine Clinical Practice.

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Introduction

Classic, questionnaires based orthopaedic outcome scores suffer from subjectivity, a ceiling effect and predominantly capture pain instead of function. Thus, they cannot account for rising patient demands or differentiate advanced surgical options stifling evidence based medicine and medical device innovation. Optical motion capture (OMC) can objectively assess function but being lab-based, time-consuming and expensive is less suitable for routine follow-up.

In this study, the clinical validity of using inertia-sensor based motion analysis (IMA) as an objective outcome measure was investigated by distinguishing patients with severe osteoarthritis of the knee or the hip from healthy controls and by comparing both patient groups to see if pathology specific gait patterns can be identified.

Materials & Methods

A 3D inertial sensor (41x63x24mm, f=100Hz) containing gyroscopes (±300°/s) and accelerometers (±5g) was attached onto the sacrum with tape (Fig 1) while performing a 20m gait test at preferred speed. Patients scheduled for primary THR (n=18; m/f= 9/9; age= 63yrs ±9; BMI= 27±5) and for primary TKR (n=18; m/f= 9/9; age=65yrs ±10; BMI= 29 ±7) were compared to healthy controls (n=30; m/f=18/12; age=61.0yrs±5.6).

Self-developed algorithms (Matlab) based on published principles produced the following parameters: Walk speed (m/s), step length (cm), cadence (steps/min) and for pelvic obliquity a) the range-of-motion (RoM, also normalised for speed) and b) the asymmetry.

In a pilot study, the qualitative and quantitative equivalency of pelvic obliquity derived by IMA in comparison to Optical motion capture (OMC) was tested by deriving both signals simultaneously during repeated walks (n=6).

Subject groups were compared (t-test, $p<0.05$) and the area under the curve (AUC) of the receiver operating curve (ROC) was used to quantify the diagnostic to distinguish TKA from THA patients (AUC>0.8: very good).

Results

The pilot study revealed matching waveforms and similar RoM of the pelvic obliquity signal for IMA and OMC (Fig 2).

Gait parameters derived from the accelerometer signal (walk speed, cadence, step length) showed a significant difference between patients and healthy controls but could not differentiate between TKA and THA patients. However, pelvic obliquity showed significantly lower RoM (4.9±1.5° vs 6.9±1.8°, $p<0.01$) with higher asymmetry (33.5% vs 15.7%, $p<0.05$) in hip patients (Fig 3). Only for pelvic obliquity parameters, diagnostic power was good (AUC≥0.7) or very good (AUC≥0.8) but poor for others (e.g. step length).

Discussion

A single inertial sensor attached onto the sacrum can measure the dynamic angular position of the pelvis during gait with comparable accuracy than with optical motion capture.
IMA derived pelvic obliquity RoM and asymmetry could differentiate THA from THA patients by identifying disease specific disturbances and compensation mechanisms: Less RoM but higher asymmetry in THA patients can be related to hip pain, decreased hip muscles' strength and the predominantly unilateral effect (e.g. Trendelenburg sign). General gait parameters such as walk speed or step length cannot differentiate this.

Fast and low-cost IMA gait analysis and dynamic pelvic obliquity could be used in routine orthopaedic follow-up to supplement conventional scoring systems with a disease specific objective functional measure.

Figures

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Figure 4 HYPERLINK "http://app.istaonline.org/figures/1686.jpg" \t "_blank"
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Figure 6

Poster: 77
#863

Accelerometry Based Monitoring of in-Patient Activity to Objectively Evaluate TJA Rehabilitation Programs.

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Introduction:

Physical activity (PA) is an important outcome parameter critical for general health, social participation and patient satisfaction. This is particularly true in orthopaedics where the movement apparatus is (electively) treated. Currently, PA is scored by questionnaires which suffer from patient subjectivity and ceiling effects. Wearable accelerometer based activity monitors (AM) to objectively measure real-life activity have become available. However, they are challenged by the less dynamic motions and use of walking aids in total knee (TKA) or hip arthroplasty (THA) patients, especially during rehabilitation. Thus their use is still scarce and focused on late (>3m) follow-up [1,2].
In-patient recovery prior to discharge is most challenging for AM but objectively monitored activity in this phase may support individualized discharge schedules or the development of fast recovery programs to serve today's health-economic pressures.
This is the first study to collect AM data of TKA and THA in-patients during post-op recovery in order to establish reference data and judge whether AM can be used to examine the recovery process.

Method:

Forthy patients (Age=71±7yrs; BMI=29±5kg/m^2; M:F=16:24) after elective, unilateral primary TKA(18) or THA(22) and following the same recovery program (discharge on day 4) were activity monitored on day1, 2 and 3 after surgery (day0). Daily post-op VAS pain scores were assessed.
The AM (3D-accelerometer, 64x25x13mm, 18g) was taped to the non-affected upper leg [Fig.1] during active daytime. An algorithm (MatLab) based on published principles [3] but optimized for patients using walking aids (daily auto-calibration) and validated in a pilot study (>95% accuracy) produced the following parameters: Duration of activities (walking, standing, upright), number of sit-to-stand transfers (STS), walking bouts, gait cycles (GC) and mean cadence (steps/min) in bouts ≥10GC. Daily changes were tested (ANOVA).

Results:

Mean recording time was 11.9±1.0 hours per day. On day1 mean activity was very low (e.g. walking: 5.5±3.2min,[Fig.2]). On day2 steep improvements were observed for VAS, all PA parameters and in all patients (e.g. walking: 27.6±16.7min, +402%,[Fig.2]). On day3, PA increased less and not for all individual patients (e.g. walking: 34.5±18.5min, +25%,[Fig.3]). Continuous improvement over all 3 days and for all patients was seen only in STS (STS day1-2: +6.6, day2-3: +6.1,[Fig.3]). No difference in gender or between THA and TKA was deteced. Age was correlated with time standing, STS and cadence. BMI was correlated with time walking and number of steps.

Discussion:

Long AM recording times show sensor reliability, user compliancy and patient comfort. Activity on day1 could

mainly be attributed to physiotherapy. On day2 all PA increased steeply but increased less on day3. Only STS showed a linear increase over all 3 days and demonstrates the complexity of the recovery process and the differential value of AM objectively describing it. Distinctive correlations with age and BMI further show the sensitivity of the method and particular parameters to factors with well described influence on outcome and rehabilitation. AM during in-patient recovery can objectify discharge or the clinical assessment of fast track programs.

References:

1) Naal et al. COOR(2010)
2) Brandes et al. Arthritis.Care.Res.(2011)
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Figures

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Poster: 78
#986

Long-Term Follow-Up Results of a Second-Generation Cementless Femoral Prosthesis With a Collar and Straight Distal Fixation Channels

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Introduction:

The purpose of the present study was to evaluate long-term results of the second-generation femoral component with a neck collar and straight distal fixation channels. Although the stem produces relatively good short- to mid-term results, there are few long-term follow-up reports, and the effectiveness of the collared and straight distal geometry of the stem has been questioned. In the present study, clinical outcomes, radiographic results, and implant survival rates after more than 10 years postoperative period was investigated, and the influence of the neck collared and straight distal geometry of the stem was also assessed.

Materials and Methods:

One hundred five patients (129 hips) who underwent primary total hip arthroplasty using cementless straight distal fluted femoral stems were followed for more than 10 years. Ninety-four hips in 80 patients were available for complete clinical and radiographic analysis. The mean age at the time of surgery was 47 years (range, 25 to 73 years old), and the mean duration of follow-up was 14.3 years (range, 10 to 18.7 years). Clinical and radiographic outcomes were evaluated and Kaplan-Meier analysis of the survival of the femoral component was performed. To evaluate the effectiveness of the neck collar, patients were divided into two groups according to collar-calcar contact and clinical and radiographic outcomes were compared between two groups.

Results:

The mean Harris hip scores improved from 58 points to 88 points at the time of final follow-up. Activity-related thigh pain was reported in 9 hips (10%). The pain was relieved spontaneously in 6 hips within 2 years postoperatively, and 3 were minor complaints that did not compromise daily activities. On the last follow-up, stable bone ingrowth occurred in 93 femoral stems (99%), and stable fibrous ingrowth occurred in the remaining one hip (1%). Proximal femoral osteolysis was observed in 81 hips (86%); however, no hip had distal diaphyseal osteolysis. Although extensive cortical resorption requiring revision surgery due to severe stress-shielding was observed in only one hip, the prevalence of overall stress-shielding was relatively high (91%) due to the prosthetic geometry achieving initial stability by tight distal fixation. There was no significant difference of clinical or

radiographic outcomes between the groups with and without collar-calcar contact. Two femoral components were revised during the study period, and the cumulative survival of the femoral stem was 99% (95% confidence interval, 98%–100%) at 10 years.

Conclusion:

The long-term follow-up of total hip arthroplasty using a second-generation cementless femoral prosthesis with collared and straight distal fluted geometry showed satisfactory results for a relatively young patient sample. However, the high rate of proximal stress-shielding and the minimal effect of the collar indicate the need for some changes to the stem design, especially for the collar and the straight distal fixation channels. Because the present femoral prosthesis is no longer available, this long-term follow-up report may prove more valuable as a reference for studies of the newly developed, collarless and distal tapered femoral prosthesis.

Poster: 79
#454

Effect of a Modular Femoral Neck System on Adjusting Intraoperative Femoral Anterversion

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Introduction

A modular neck system (interchangeable neck, Wright Medical Japan) can be useful to obtain ideal femoral anteversion and to adjust offset and leg length at the same time in cementless total hip athroplasty. In this modular system, femoral anteversion is increased or decreased by 8 or 15 degrees anterior or posterior leaning of the neck to connecting plane between the femoral stem and neck. However, it is not well clarified how well this modular neck works changing of native femoral anteversion on a coordinate system for evaluating intraoperative femoral anteversion because femoral long axis is not perpendicular to the connecting plane.

The purpose of this study was to investigate the effect of this modular femoral neck system on adjusting the femoral anterversion using three dimensional model of the femur with an anatomical stem (ANCA Fit, Wright Medical Japan)

Methods

Fifty-four patients scheduled for cementless THAs underwent computed tomography (CT) scanning and three dimensional preoperative planning. There were 8 males and 46 females with an average age of 63.8 years (range, 31–86 years). The preoperative diagnosis was osteoarthritis in 48 patients, osteonecrosis of the femoral head in six patients. The anatomical stem was templated three-dimensionally (3D) on femur in multiplanar reconstructed views of preoperative planning software (Zed hip, LEXI). Once the stem was templated, the software showed 3D surface-rendered models of the stem, neck, prosthetic head, and femur from which femoral head was resected. We established the coordinate system for evaluating intraoperative femoral anteversion as follows; x-axis, line between postero-medial and -lateral condyle tips of the knee, y-axis, line between midpoint of the both condyle tips and the posterior tip of the greater trochanter, z-axis, line perpendicular to a plane with x and y axes. Angle between x-axis and a line connecting between most proximal point of the stem shaft and center of the prosthetic femoral head was defined as intraoperative femoral anteversion. Then we measured the variation of the anteversion with 8 or 15 degrees neck, compared with the anteversion with straight neck.

Results

The anteversion with the straight neck was 27.7 degrees (Standard Deviation (SD), 9.7 degrees). The variation of the anteversion using 8 degrees anteverted / retroverted neck was 5.7 degrees (SD, 1.4 degrees) and -6.0 degrees (SD, 1.1 degrees) respectively. While, The variation of the anteversion using 15 degrees anteverted / retroverted neck was 8.9 degrees (SD, 1.4 degrees) and -9.3 degrees (SD, 1.7 degrees) respectively.

Discussion

Our result showed that the effect of modular neck was slightly smaller than the perspective on our defined coordinate system for measuring intraoperative femoral anteversion. We think that the result might be from femoral anterior or varus-valgus bowing as well as the difference of two coordinate systems, which are the

connecting plane between the stem and the neck and the aforementioned plane for evaluating the intraoperative femoral anteversion. Establish of definition of femoral anteversion is needed like definition of acetabular component (anatomical, operative, radiographic, etc).

Poster: 80
#797

Bacterial Adhesion Behavior and Bone Formation Effect of Zoledronic Acid (ZOL) Immobilized Hydroxyapatite Implants

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INTRODUCTION:

Bisphosphonates are well known drugs that can inhibit bone resorption and normalize the high rate of bone turnover that characterizes osteoporosis. Recently, hydroxyapatite (HA) has been used as bisphosphonates local delivery system to enhance peri-implant bone formation, and the results are generally encouraging. In the present study, a thin film HA coating with strong adhesion and bioactive microstructure prepared by radio frequency (RF) magnetron sputtering technique was used as bisphosphonate carrier. Microbial adhesion and the accumulation of pathogenic biofilms are considered to play major roles in the pathogenesis of peri-implantitis and implant loss. In addition, bisphosphonate- related osteonecrosis of the jaw (BRONJ) has become a big concern lately. A recent study reported that zoledronic acid (ZOL) promoted the adherence of streptococcus mutans to hydroxyapatite and the proliferation of oral bacteria. The purpose of the present study is to find out a coating concentration which can improve peri-implant bone formation but minimize bacterial adhesion.

METHODS:

Custom made sputtered HA coated titanium cylinders, measuring 1 mm in diameter and 15 mm in length, were used as the substrate materials for ZOL (Novartis Pharma AG, Switzerland) application. The averaged thickness of the sputtered HA coating was 1.5 μm. Twelve 24 weeks old female Wistar rats were randomly assigned into four groups: (1) control group (without ZOL treatment); (2) Low dose group (0.5 μg/implant); (3) medium dose group (2μg/implant); (4) high dose group (10μg/implant). Each implant was inserted in the medullary cavity of a femur from the intercondylar notch. After 2 weeks healing, animals were sacrificed and femora were harvested for micro-CT and histology analysis. Bacteria were cultured on the samples with different amount of ZOL, and analyzed with the Live/Dead BacLight bacterial viability kit.

RESULTS:

In all the histological sections, no detachment of the HA coating was noted. The low dose and medium dose groups showed significantly higher bone implant contact than the control and high dose groups. There was also a significantly larger peri-implant bone volume in the low dose group than in the control and high dose groups, which was consistent with the result of mineral apposition rate. In addition, no significant difference in bacterial adhesion was observed among groups.

DISCUSSION & CONCLUSIONS:

The results indicated that the ZOL released from the sputtered HA coating stimulated peri-implant bone formation at relatively low dose (0.5 μg and 2μg) which is even less than the previous study by using plasma spray HA coating. This may be due to the small crystallite size (around 100nm) of the sputtered thin film HA, which was supposed to increase the effectiveness of ZOL absorption. Further more, the bacterial adhesion to the HA implant was not effected by the application of ZOL. A long-term in vivo study should be performed to test the coating degradation.

Poster: 81
#551

Does the Incidence of the Ponticulus Posticus Differ Among Races?

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Introduction:

C1 lateral mass screws have been accepted as one of the validated surgical options. The technique to insert screws via the posterior arch, the so-called Tan's technique, has been reported and we have previously shown the anatomic and biomechanical validity of this technique. However, the presence of the posterior ponticulus (PP) may deceive the surgeon into inserting the screws in the wide lateral arch and injuring the vertebral artery. To avoid this catastrophic complication, preoperative evaluation is extremely important. However, correct diagnosis of PP using only plain radiographs may be difficult. Based on our clinical experience doing surgery on the craniovertebral junction, the incidence of PP for Japanese patients seems to be lower than that reported in the literature. This study investigated the incidence of PP in Japanese patients and determined the intra-observer differences among imaging modalities to detect its incidence.

Methods:

Using both plain lateral radiographs and 3D-CT images obtained from 197 patients at Nagoya City University and the affiliation hospital, we investigated the incidence of PP. Differences in the detection rates of frequency between plain x-rays and CT images were compared. The numbers of complete PP and incomplete PP (partial osseous bridging) were counted by 3D-CT images.

Results:

We detected PP in 26 cases by CT images; however, PP was detected in only 16 cases by plain radiography. The 3D-CT investigation revealed that the incidence of complete type and incomplete type was 3.0% and complete type was 5.3% , respectively. The overall incidence was 8.3%.

Conclusion:

3D-CT images were superior to plain radiographs for detecting PP. To prevent VA injury, preoperative 3D-CT evaluation is mandatory for better understanding and recognition of the PP. Various incidence rates have been reported for PP. For example, the incidence of PP was 15.0% for the black population, 11.4% for the white population, and 9.4% for a population of Turks. In this study, the incidence of PP for the Japanese population was lower than that reported for other races. These results might suggest that a racial difference exists in the incidence of PP. Further investigation is warranted.

Poster: 82
#946

How Does the Lateral Flare Work?-Comparering With or Without Lateral Flare-

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Introduction

Three dimensional preoperative planning for each patient has been done in our institution. Anatomical designs of prosthesis are necessary to realize primary stability. But the femoral shape, especially intramedural canal is different in each patient. In previous study, we reported CORTEX/STEM RATIO MAPPING as a method to visualize the area which concerns about initial stability and load transfer post-operatively.The purpose of this study is to compare the difference of the high ratio areas of Revelation stem with or without Lateral Flare and to inspect the lord transfer region using finite element analysis.

Materials & Methods

<CORTEX-STEM RATIO MAPPING>

A preoperative three-dimensional planning based on CT-scan data was performed. STL data of two different contour of Revelation stem; (1) stem with Lateral Flare, (2) stem without Lateral Flare; were studied.CORTEX-STEM RATIO was mapped on the surface of the stem like contour lines.

<FINITE ELEMTNTAL ANALYSIS>

Finite elemental model was made from STL data of Revelation stem (with Lateral Flare) and CT-scan data.

Model 1: distal canal reamed same diameter

Model 2: distal canal reamed over 1mm diameter

Femur distal constrained, lording force applied as Fig.1.

Material properties of each body are defined as Fig. 2.

Results

<CORTEX-STEM RATIO MAPPING>

Cortex-stem ratio of stems without Lateral Flare of proximal femur indicated over 90% at medial and 85~95% anterior, but no more than 70% at posterior and lateral. On the contrary, cortex-stem ratio of Revelation stems with Lateral Flare was shown 90~100% at medial and lateral, 85~95% at anterior portion.

<FINITE ELEMTNTAL ANALYSIS>

Although small lord transfer area was observed on proximal part of the stem, main area of lord transfer was indicated on distal part of it in Model 1. On the other hand, lord transfer area was observed at lateral, medial and anterior aspects of proximal of the stem in model 2 that represented the correct surgical technique for Revelation.

Discussion

High ratio region of CORTEX-STEM RATIO represent a great difference between stems with Lateral Flare and stems without Lateral Flare. These regions participate in primary fixation and lord transport to femoral cortex. The results indicated that Lateral Flare is important to obtain proximal stability in cementless stem.

Finite elemental analysis of two different models indicates that Revelation stem (performed correct surgical technique) obtain proximal fixation and lord transfer.

High interface pressure areas of proximal stem were resemble to high ratio regions of CORTEX-STEM RATIO. Three-dimensional mapping of CORTEX-STEM RATIO is useful technique to better understanding the relative position between the stem and the femur, to evaluate which regions were concerned with initial stability after operation and lord transfer later.

Figures

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Figure 4

Poster: 83
#842

Muscle Activation and Coordination in Patients With Massive Rotator Cuff Tears

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Introduction:

Massive rotator cuff tears (MRCT) are prevalent in the elderly population. They cause significant pain, weakness and limitation in range of motion and have a negative impact on patients' quality of life. Adaptive muscle activation strategies related to MRCTs are poorly understood. Furthermore, alterations in muscular coordination have not been previously studied. This indicates a significant gap in the literature given the reliance of the shoulder on synchronous and coordinated muscle activation amongst all shoulder girdle muscle groups. Current treatment options are unsatisfactory and a further understanding is necessary to improve rehabilitation protocols. Electromyography (EMG) was used to investigate both muscle activation and coordination in patients with MRCT during an arm elevation task based on activities of daily living.

Methods:

Fourteen healthy controls and 11 patients with a MRCT were included. Shoulder function was assessed using the Functional Impairment Test-Hand, Neck, Shoulder and Arm (FIT-HaNSA); a reliable and valid test for the assessment of functional status in patients with a spectrum of shoulder pathologies. EMG was recorded from 13 muscles using a wireless EMG system during a reliable and accepted EMG testing protocol which involved consecutive lifting of a weight from a low shelf to a high shelf (phase 1) and back (phase 2). Muscle group data was calculated by ensemble averaging the activity of the individual component muscles. Mean signal amplitude and Pearson correlation coefficient (PCC) analysed muscle activation and coordination, respectively.

Results:

The mean FIT-HaNSA score in the control group was 97% (SD+5) as compared to 29% (SD+11) in the MRCT group ($p<0.001$). The weight remained on the high shelf for a significantly longer time in the MRCT group (0.471s + 0.3) compared to the control group (0.19+.13) ($p=0.015$). During phase 1 (arm elevation) signal amplitude was significantly higher for the elbow flexors ($p<0.001$) and upper trapezius and serratus anterior ($p=0.025$) muscle groups in the MRCT patients. Mean amplitude was also greater for the deltoid ($p=0.007$), latissimus dorsi-teres major ($p=0.007$), and rotator cuff ($p=0.021$) groups during arm elevation in patients with MRCT. Correlation between the muscle groups inserting on the humeral head was high for both controls and MRCT patients (PCC = 0.85-0.91). This is illustrated graphically in Figure 1.

Discussion and Conclusion:

MRCTs have a detrimental impact on shoulder function. Patients modify their movement strategy to incorporate longer periods of rest following arm elevation. There is a reorganisation of muscle activation strategy along the upper limb kinetic chain in MRCT patients. Increased activity of the scapula and elbow flexing muscles represents adaptations within proximal and distal segments of the kinetic chain, reducing demand on the glenohumeral joint. Further, increased activation of the latissimus dorsi and teres major muscles compensates for the deficient rotator cuff in balancing the destabilising forces of the deltoid. Understanding adaptive muscle activation strategies provides a basis for targeted rehabilitation strategies.

Figures
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Figure 2

Poster: 84
#649

Total Knee Arthroplasty in Extension Bony Ankylosis Knees

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[Abstract]
Objective:

The method and curative effect of primary total knee arthroplasty(TKA)are approached in extension bony ankylosis knees

Method:

Form June 2000 to June 2007, 10 patients with extension bony ankylosis knee(12 knees)receive TKAs, all the operations were performed by medial parapatellar approach , rectus snip for exposure, sccondary osteocomy and Soft tissue balance for knees with bony ankylosis in extension position, the operation effect is estimated by the range of motion and HSS score system pre- and postoperatively,and observe the post-operation surgical complications.

Result:

10 patients (12 knees) were followed up with a average period of 63.2 months (3-10 years), HSS score improved from average 32.5 points(14～48 points) preoperatively to average 87.75 points(78～95 points) postoperatively, HSS score of pain improved from average 8.75 points(5～15 points) preoperatively to average 26.67 points(20～30 points) postoperatively, the average knee joint range of motion(ROM) improved from 0°preoperatively to 93.75°（range, 70°to 120°）postoperatively, all this was significantly improved compared with the preoperative value（$P<0.01$）, postoperative there are several surgical complications happened, 2 patients had Cutaneous necrosis, one had deep veins of lower limb; one patient recevied revision total knee arthroplasy due to prosthesis deep infection, there is no sense of looseness of the prosthesis.

Conclusion: Despite the relatively high complication rates and less than desired postoperative motion, most of our patients achieved an improvement in function. Based on our data and the literature, we therefore believe the procedure worthwhile even in patients with bony ankylosis knees

[keywords]: knee joint; extension position; bony ankylosis; total knee arthroplasty

Poster: 85
#540

Cemented Versus Press-Fit Placed Stems in Revision Total Knee Replacement: A Randomized Controlled Trial

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INTRODUCTION

The number of revisions of total knee replacements (TKR) increases annually. Because of reduced bone stock, stable fixation of the implant is important. The femoral and tibial components are usually cemented. The stems can be placed either by cementing or press-fit. To date, there is no consensus on the preferred stem fixation technique. This is the first study assessing stability of revision TKR using radiostereometric analysis (RSA). The primary goal of this study was to assess the stability of cemented versus press-fit placed stems. Secondarily, the clinical results were compared between the groups.

PATIENTS AND METHODS

In this randomized controlled trial 32 patients needing revision TKR were included; allocation into the cemented or press-fit stem groups occurred by randomization during surgery. Only patients with type I or II bone stock loss (Anderson classification) were included. Migration of the femoral and tibial implants (translation or rotation > 1 mm or °) was measured with model-based radiostereometric analysis (MB-RSA). During the first 5 postoperative days the baseline RSA radiograph was obtained. Patients were followed at 6 weeks, 3, 6, 12, and 24 months. Migration (translation and rotation) of the tibial and femoral implant in 3 dimensions was calculated at each follow-up moment and compared with baseline. At 6 weeks, double RSA radiographs were obtained in order to assess the reproducibility of the measurement method. Clinical results were evaluated using the Knee Society Score, the KOOS, active flexion, and VAS pain and satisfaction.

RESULTS

Reproducibility of the MB-RSA method was good: precision of translation and rotation of the femur and tibia components were below 1 mm / °. Maximum Total Point Motion (MTPM) was less reproducible: 1.08 mm for

the tibia and 1.61 mm for the femur. At 6 and 12 months, no difference in median migration for the femoral and tibial components was found between the cemented and press-fit placed stems. However, the number of migrating implants at 12 months showed a trend towards more migration for the cemented stems (p=0.083). None of the clinical scores differed between the groups.

DISCUSSION AND CONCLUSION

Cemented and press-fit placed stems were equally stable at 6 and 12 months of follow-up. Although not statistically significant, the number of migrating implants might be a factor of interest. Unexpectedly, both groups showed migrating implants, whereas there were no clinical or radiological signs of loosening. MTPM was quite high for almost all patients, theoretically indicating a possible increased risk for loosening. The migration mechanism of this specific group of implants needs to be unraveled.

Conclusion: to date there is no difference in stability and clinical outcome between cemented and press-fit placed stems. However, this is a preliminary conclusion, since not all patients have completed the two-year follow-up.

Poster: 86
#466

Advanced Fixed Bearing TKA Locking Mechanism Minimizes Backside Micromotion

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Introduction:

A major concern in the use of modular knee implants has been particle generation from the backside of the UHMWPE tibial insert. Motion, commonly referred to as micromotion of the tibial insert against the proximal tibial tray can generate microscopic particles that with time can propagate throughout the joint and lead to osteolysis, a condition that can promote bone resorption and finally, implant loosening [1,2]. This study was undertaken to develop a simple and sound approach to characterizing modular knees.

Materials and Methods:

Six competitive products; Optetrak n=(1) (Exactech, Inc), NexGen(3) (Zimmer, Inc.), Journey(1) (Smith & Nephew), Advance(1) (Wright Medical), Scorpio(1) and Duracon(2) (Stryker) were tested along with 2 DePuy products: PFC Σ XLK(5) with i2 locking mechanism, and Attune AO Poly-M(3) with Attune locking mechanism (DePuy Orthopaedics). All specimens were taken from sealed packages.

Trays were cemented in fixtures using Ultracryl II epoxy (Masel) and cured before milling 2-holes in insert for a multi-directional load applicator. Each construct was soaked in 37C RO water for a minimum of 12-hours before testing.

An MTS 858 Bionix test frame with MPT software was used for testing. Micromotion was measured using Heindenhain ST 1278 encoders (± 0.5 um) fixed to a custom fixture mounted to the tray-fixture.

A 0-N (Newton) compressive load was maintained for all test directions.

The A/P and M/L micromotion tests applied a 100-N load through the holes in the tibia insert and reversed to apply 100-N in the opposite direction.

Micromotion was defined as the measured displacement between the minimum and maximum load positions.

For the RT (rotation) micromotion test, a 1-N-m ramp torque was applied in the counter-clockwise direction, followed by a 6-N-m CW ramp torque.

Results:

“R” is a compilation of the AP and ML micromotion and was calculated by taking the square root of the sum of the squares of AP and ML.

Standard deviation was calculated for each sample, where applicable, and ranged between 0% and 47% of the mean.

Discussion:

Measurement capability appears to range from constructs demonstrating extremely small micromotion to those exhibiting relatively large motions. This approach has the advantage over contemporaries [3,4] by actuating the insert while avoiding insert clamping that can over-constrain and distort the insert. It features fixtures of limited complexity with greater stability. The Heindenhain encoders present improvement in accuracy over other measurement devices.The means and standard deviations for designs having samples of n = 3, or greater, are as follows: Attune AO (15 ± 1), PFC Sigma XLK i2 (16 ± 4), and NexGen (82 ± 14), with NexGen being statistically different ($p < 0.0001$). The methodology shows the ability to distinguish between different manufacturer’s designs even with small sample sizes. Clearly, careful attention to design details can result in very significant differences in micromotion behavior.

References:

1. Parks NL et al, Orthop Trans, 18, 1994; 2. Wasielewski RC et al, Clin Orthop, 345, 1997; 3.Taki, N et al, Soc For Biomat, 28th Annual Meeting Transactions, 2002; 4. Parks NL et al, Clin Orthop, 356,1998

Figures

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Figure 1 HYPERLINK "http://app.istaonline.org/figures/418.jpg" \t "_blank"
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Figure 2

Poster: 87
#918

Effect of Thermal Treatment on the Wear of Radiation-Crosslinked UHMWPE With and Without Vitamin-E

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Ultra-high molecular weight polyethylene (UHMWPE) has been successfully used as a bearing material in total joint arthroplasty. However, longevity of these implants has been compromised by wear and fatigue damage of the polyethylene. The addition of vitamin E to the polyethylene is a process utilized to stabilize free radicals produced during radiation crosslinking. Recent studies on UHMWPE that contains Vitamin-E indicate that post-irradiation thermal treatment, either in the form of remelting or annealing, may not be necessary for improving the oxidation resistance since residual free radicals are effectively neutralized by Vitamin-E. However, it is unclear how the wear resistance of Vitamin-E containing UHMWPE would be affected by post-radiation thermal treatment. The objective of the present study is to determine the effect of thermal treatment on the wear resistance of radiation-crosslinked UHMWPE with and without Vitamin-E stabilization. Two materials with three treatment conditions were evaluated in this study, as shown in figure 1. The vitamin E material contains 1000 ppm of vitamin E; which was blended into the GUR 1020 UHMWPE resin before consolidation. Wear testing was conducted with 32 mm acetabular cups on a multi-station hip stimulator (MTS, Eden Prairie, MN). The simulator used a physiologic loading pattern with a maximum load of 2450N. The test was conducted under standard clean conditions with alpha calf fraction serum diluted to a protein concentration of 20 g/l for a total of 2 million cycles. All cups ran against CoCr femoral heads, and gravimetric measurements were taken every 500,000 cycles. Wear rate results are shown in figure 2. Results show no statistical difference ($p>0.05$) in wear rate for any of the materials containing vitamin E regardless of thermal treatment while polyethylene without vitamin E shows a significant reduction in wear rate as a function of thermal treatment. All of the materials without vitamin E had better wear characteristics than vitamin E containing polyethylene. The effect of vitamin E on the wear characteristics of UHMWPE were investigated in this study. This study shows that regardless of thermal treatment, the addition of vitamin E negatively affects the wear characteristics of polyethylene by at least 40%. These results suggest that the addition of vitamin E significantly decreases the ability to create crosslinks during both irradiation and post-irradiation thermal treatment and consequently increasing wear rate.

Figures
Poster: 88
#455

Randomized Prospective Comparison Between Duration and Conventional UHMWPE: Averaged 12 Years Results

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Introduction:

This study evaluates the effect of Duration® UHMWPE (PE) compared to conventional PE gamma irradiated in air for primary THA averaged 12 years follow-up.

Methods:

Forty-eight primary THA were performed for all women DDH patients with randomization. Group I had 28 Duration® heat-stabilized PE, and Group II had 20 same design PE gamma irradiated in air. Same design acetabular shell, uncemented-stems, and 22 mm CoCr femoral heads were used in both groups. Averaged age in Group I and II was 64 and 63, follow-up was 134 and 168 months, respectively. Wear measurement was performed with Martell's method.

Results:

Averaged 2-D wear rate was 0.073 mm/year in Group I and 0.125 in Group II ($p<0.05$). Three dimensional wear rate in Group I and II showed 0.116 and 0.191 mm. Seven bilateral patients with different PE showed Duration®

had lower penetration in both 2D (0.063 mm in Group I, 0.127 in Group II) (P<0.05) and 3D (0.116 mm and 0.189) (p<0.05). First and second year had higher rate in both groups compared to after 3rd year. Thicker polyethylene had lower penetration in both groups (p<0.05). One was revised with cup loosening in group II. 2 mm or more head migration were found 3 cases in Group II.

Discussion & Conclusion:

Sycterz reported penetration was higher in first several years. Wroblewski demonstrated 22mm head had 0.21 mm/year penetration averaged 86 months. This study showed first and second year had higher (probably penetration), but it stabilized after third year. McKellop reported Duration® PE had better wear performance compared to other conventional PE. Although highly crosslinked no free radicals PE had good performance, longer follow-up need to clarify the oxidative changes of this type PE in vivo.

Poster: 89
#457

Effect of M/L Taper Kinectiv Stem to Reduce Impingement With DDH Patients

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Purpose:

Neck and cup impingement resulted in producing larger amount of wear and risk for dislocation after total hip arthroplasty. DDH had more complex to adjust combined cup and femoral neck anteversion during surgery. Purpose of this study was to evaluate neck-cup impingement with neck changeable Kinectiv stem for DDH patients.

Materials & Methods:

Single surgeon's series were analyzed neck cup impingement during 418 primary total hip surgeries with DDH. 52 hips in men, surgical approach were 293 mini-one antero-lateral, 88 mini- Watson-Jones, and 37 Hardinge. Acetabular cups were seated 20 degrees anteversion. Kinectiv Stem (Zimmer, Warsaw, IN) was inserted manually with standard technique. All femoral head diameter were 26 mm with crosslineked flat liner PE. First trial was performed with straight type of neck and 26mm femoral head based on preoperative templating. At neck and head trial to evaluated antero-superior impingement with "flex+Add.+IR" and potero-inferior impingement with "ext. +add.+ER". If the neck and cup impingement occurred even if no dislocation, necks were replaced counter version or larger offset.

Results:

Neck trial was 2 to 3 times during surgery (ave. 2.5). Version was changed 212 cases. Surgeon selected larger offset in 86, 78 longer length, 48 shorter length. Larger offset with longer length in 76, 22 had larger offsets and shorter length compared to 2D templating before surgery. We had 2 dislocations (0.48%) fixed with manual reduction. All were using very short neck (E; minus 4 in length and S; minus 4 in length, plus 4 in offset) with smaller arc of movement type because of tight to reduct compared expected proper positions. All dislocated cases were revised with larger femoral head. Our last 5 year's primary THA dislocation rate were 0.81% (17/2088) (p<0.05). Averaged hospital stay was 7 (4-12) days.

Discussion:

One Kiective stem had 60 variety of necks based on 4 mm head center difference. Large amount of variation especially anteverted or retroverted neck selection might reduce neck-cup impingement compared to other straight type of femoral stems. Combined anteversion is very important especially in DDH patients, because of larger feoral anteversion. Proper offset and leg length are also very important issues for any type of patients. This type of stem had more advantages than straight type monolithic stems to reduce wear and dislocation caused by impingement. Care must be taken for reducing impingement with selecting shorter length or offset during surgery.

Poster: 90
#1029

The Comparability of the Tuberculum Majus of Different Species Used for Testing Bone Anchoring Implants

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Knowledge of interspecies differences between human healthy, human osteopenic, ovine, bovine and porcine species is of special importance, since these species are used for the *in vitro* mechanical testing of bone anchoring implants, such as suture anchors, or for testing the bones directly. A recent study found significant differences in the pullout strength of suture anchors between different species [Pietschmann, M. F., Hölzer, A., Rösl, C., Scharpf, A., Niethammer, T., Jansson, V., Müller, P. E.: What humeri are suitable for comparative testing of suture anchors? An ultrastructural bone analysis and biomechanical study of ovine, bovine and human humeri and four different anchor types. Journal of Biomechanics 43 1125-30, 2010]. In the present study the trabecular microstructural parameters (bone volume fraction, trabecular thickness, trabecular separation, trabecular number, connectivity density, degree of anisotropy and structure model index) and the mechanical properties (Young's modulus and strength) of the *tuberculum majus* of the humeral head were measured in human healthy, human osteopenic, ovine, bovine and porcine bones using micro-computed tomography and mechanical unconfined testing, respectively.

The values of the trabecular microstructural parameters generally differed between the species. Thus, only the original species should be used in *in vitro* mechanical tests on the stability of implants in trabecular bone. The interrelation of the trabecular microstructural parameters was determined using multivariate regression analysis in order to avoid confounding effects. The multivariate regression analysis showed that the microstructural parameters have similar principal interrelations in all species; this could indicate that the design of trabecular microstructure in the *tuberculum majus* follows similar phenomenological mechanisms in all species. Mechanical tests of the same specimens are in progress. Preliminary results suggest that the mechanical properties are different among the species as well. Final results including multivariate regressions between mechanical properties and microstructural parameters will be presented at the annual congress of the International Society for Technology in Arthroplasty.

Poster: 91
#507

Wear Simulation and Life Prediction of a Typical Modular Hip Stem-Neck Taper Junction

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Orthopaedic implants such as those used in hip arthroplasty can be either single component or "modular" devices, consisting of two or more components connected using a modular junction. Although modular implants have many advantages, the modular design itself introduces the potential for small amplitude relative motion to occur, known as fretting. Fretting typically results in the generation of wear debris with the potential for adverse biological effects, and the initiation of surface cracks which may result in premature implant failure.

Current research in the field of aero-engine design has shown that the presence of fretting can cause significant reductions in fatigue life. In these studies, component life was predicted by simulating material removal due to wear of the components and taking into consideration the effect of wear on fatigue damage. By adapting this methodology for orthopaedics, the wear generated at the modular connections and the life of modular implants can be predicted, something that has so far eluded orthopaedic researchers. This study presents an adaptation of this methodology to orthopaedics using as an example a circular taper connection representative of a typical hip implant stem-neck modular junction. All analyses were performed using ABAQUS finite element software (Simulia, RI, USA).

The male and female titanium alloy components were assembled using three methods: (1) hand assembly, (2) constant rate assembly by application of a static load to 2kN, and (3) a drop weight assembly method using a 0.907kg weight dropped from a 10 inch height. For each of these assembled components, a fretting wear analysis was performed using ABAQUS together with custom written code implemented through user subroutine UMESHMOTION. Each analysis consisted of several steps, in which the base of the female component was fixed and the male component was loaded cyclically as outlined by ASTM 1875. Subroutine UMESHMOTION was used to calculate and apply the wear on the contact surface of both components. Wear was calculated using Archard's equation and applied at the end of each step. An acceleration factor was used to speed up the analysis while maintaining stability of the solution. This subroutine was also use to implement a unique method to track the location of points in the material mesh, such that results could be obtained at a consistent set of points to facilitate life predictions. At the end of each step in the fretting wear analysis, a fretting fatigue analysis was performed. This involved running custom written code through ABAQUS/Make to analyse the step results. For each step, the Smith-Watson critical plane parameter was calculated for each point in the material mesh and a linear and isotropic damage accumulation model was used to predict the life of both components.

The results showed that the taper assembled using the drop weight method was significantly more stable than the tapers assembled with the other methods. This resulted in a reduced wear debris volume and increased fatigue life.

This study demonstrated how to optimise the taper connections in modular implants in terms of both wear debris production and fatigue life.

Poster: 92
#850

Intercondylar Notch Resection Volume of Posterior Stabilized Knee Arthroplasty - Effects of Implant Alignment and Design

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A key design feature of the Optetrak® Logic® PS (posterior stabilized) total knee arthroplasty (TKA) prosthesis* (Exactech®, FL, USA), is the cylindrical intercondylar box which differs from commonly seen rectangular box designs (Figure 1). This cylindrical box design offers several advantages including a simpler surgical procedure, the elimination of sharp bone corners, and less bone resection during notch preparation. It has been shown that the Logic® PS femoral component reduced bone resection during notch preparation about 30% compared to a predicate prosthesis at ideal implant alignment [1]. However, in surgeries, the prosthesis may be implanted with some deviation from the ideal position due to patient anatomy, surgeon's choice, etc. The purpose of this study was to evaluate the theoretical effects of prosthesis alignment deviations on the cylindrical notch resection volume of a Logic® PS compared to a predicate Optetrak® Hi-Flex® femoral component.

A generic digital femur model (Zygote Media Group, UT, USA) was used in this study. The geometrical analysis was performed in CAD platform NX 7.5 (Siemens PLM, TX, USA). A size 3 Optetrak® Logic® PS and a size 3 Optetrak® Hi-Flex® femoral component along with their specific instrumentation were modeled to perform the virtual TKA surgeries. Standard bone cuts were performed on the distal femur, and the intercondylar notch was prepared for both Logic® PS and Optetrak® Hi-Flex® models (Figure 2). The notch resection volume was measured on each. In addition to the "ideal" position, deviation ranges of -6° to +10° flexion, -8° to +8° varus, -6° to +6° internal rotation, -4 mm to +4 mm anterior translation, -10 mm to +10 mm medial translation, and -4 mm to +8 mm proximal translation were imposed and the resultant notch resection volumes were calculated. (For investigation purpose, these deviation ranges were larger than most commonly seen deviations.)

Figure 3 shows the bone resection volumes for both Optetrak® Hi-Flex® and Logic® PS notch preparation, including the effects of each alignment deviation. The effects of the alignment deviation varied depending on the specific direction, but the Logic® PS femoral component consistently resulted in less notch resection volume than

the predicate Optetrak® Hi-Flex® under all conditions. Within the typical alignment ranges (green shaded areas in Figure 3), the Logic® PS preserved 22% to 28% bone volume during notch preparation.

This study compared the notch resection volume of two TKA femoral components. Consistent with previous reports, the Optetrak® Logic® PS resulted in less bone resection benefiting from its cylindrical box design. This study further indicated the robustness of this bone preservation mechanism under situations where the prosthesis may not be perfectly aligned. As a pilot study, this analysis only included one femur model (i.e., no anatomical variability was considered) and all the deviations were analyzed individually. Future studies considering more bone models and the coupling effect of multi-deviations will be needed to strengthen the conclusions drawn from this study.

*US and foreign patents granted and pending.

[1] Angibaud et al., The 56th Orthopaedic Research Society Annual Meeting, New Orleans, USA, 2010.

Figures

Poster: 93
#917

Does the Regulation of National Health Insurance Influence the Prescription Patterns of Glucosamine Sulfate?

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Background:

Using 5-year nationwide population-based data for Taiwan, this study compared the dosage and different prescription patterns of glucosamine sulfate and evaluate the influence of the prescription guidelines by National Health Insurance (NHI).

Methods:

The study sample was drawn from the Taiwan National Health Insurance Research Database from January 1, 2004 to December 31, 2008. A total of 10,501 patients with osteoarthritis were included. We compared 271 patients who started to receive glucosamine since 2005 with characteristic-matched 593 patients who never receive glucosamine.

Results:

The mean duration of the glucosamine-treated group was 40.38 months while that of the non-treated group was 45.82 months. The most common prescription pattern was 250 mg taken 3 times a day for the period of 3 months and then stopped for 3 months (54.2%). It was the same way indicated and covered by National Health Insurance. Only 0.7% of the patients used recommended daily 1500 mg dosage. According to the utilization patterns of glucosamine sulfate, the result showed that the patients using glucosamine sulfate have a higher incidence rate of undergoing knee replacement surgery. (7.4% vs. 2.7% , p=0.001).

Conclusions:

The prescription guidelines by National Health Insurance may cause a patient selection bias with decreased efficacy of glucosamine sulfate. The physicians also tend to have a prescription pattern with a daily 750 mg dosage that was lower than the recommended therapeutic dose.

Poster: 94
#839

Monitoring and Lifetime Assessment of Hip Endoprothesis in Vivo

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This contribution discusses the construction of a monitoring unit based on MEMS technologies for patients those have their hip joints replaced with prosthesis. The objective is to monitor the stress applied on the hip joint where it alerts the patient when the levels of the load reaches critical levels thus, prolonging the lifetime of the prosthesis. The step reached for now is the construction of a functional telemetric system connected to three strain gauges that are to supply us with needed data for monitoring the loads, these data are processed according to simulations in FEM environments, and also from derived equations describing the relation between strain, normal stress and bending moments respectively. In the case of permanent monitoring we can calculate the real damage for individual patients and subsequently to assess the total accumulated damage and the rest lifetime of endoprothesis. The telemetry is supplied with energy by induction or energy harvesting system; the antenna serves as an energy source as well as a receiver of RF signal to be processed. The energy harvesting system accumulates kinetic energy in the form of electric energy to supply the whole monitoring system. The next step will be clinical testing and later on is to be reduced in size to fit the prosthesis.

Poster: 95
#845

TKA Technique After Long-Standing Ipsilateral Hip Fusion

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Purpose

Purpose of this paper is to present the TKA technique and clinical results. We experienced two cases of TKA after ipsilateral hip fusion. Our indication for ipsilateral TKA is no malposition of hip fusion. A conventional surgical approach was employed.

Case presentations.

Case 1: 60-year-old female. She suffered right hip pyogenic arthritis at age 10 and received hip fusion at age 11. She was diagnosed with both right knee and left hip osteoarthritis. She complained of left knee pain with walking disturbance at age 58. The right hip Joint was fused in a position of flexion 20 degrees and abduction 0 degrees. Knee extension was -10 degrees and flexion was 90 degrees. JOA score of her right knee was 40 points. TKA was performed with a regular PS implant. Her JOA score improved to 55 points 2 years after surgery. Case 2: 70-year-old female. She suffered left hip Tbc at age 10. Her Tbc healed by conservative therapy with varus hip ankylosis. She received valgus hip osteotomy at age 40. She was diagnosed with bilateral knee OA at age 60. Her left hip joint had ankylosis with a position of flexion 20 degrees and abduction 15 degrees. Knee extension was -10 degrees and flexion was 80 degrees. JOA score of her left knee was 40. She received Light TKA at age 70. Her JOA score improved to 55

Conclusions

Indication of TKA technique after long-standing ipsilateral hip fusion was no malposition of fused hip. The key technical key point of this surgery is to keep good knee ROM during surgery. Use a supine position and set a sand bag under the pelvis to keep the forward-bent posture with a hip flexion of 50 degrees. Two cases were presented. Their results were acceptable like Romness and Morry but not excellent.

Poster: 96
#672

Total Shoulder Arthroplasty for Glenohumeral Osteoarthritis and Rheumatoid Arthritis -2nd Generation vs 3rd Generation-

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(Purpose)

Third generation total shoulder arthroplasty (3^{rd} TSA) has been expected to improve clinical results and survival rate of implant because of the peg type glenoid component, eccentric humeral head, and mismatch between the head and glenoid. The purpose of this study was to compare the clinical and radiographic results of 2^{nd} TSA and 3^{rd} TSA for osteoarthritis (OA) and rheumatoid arthritis (RA).

(Materials and Methods)

For OA, 2^{nd} TSA was performed in 13 shoulders (average age at the operation; 70.5 years old, follow-up period; 42.7 months) and 3^{rd} TSA in 10 shoulders (71.9 years old, 27.4 months). For RA, 2^{nd} TSA in 10 shoulders (63.0 years old, 54 months) and 3^{rd} TSA in 14 shoulders (61.1 years old, 21.6 months). Shoulders that had irreparable cuff tear at the time of surgery were excluded. The Japan Orthopaedic Association shoulder score (JOA score) (100 points as full marks), ROM, and lucent line or loosening of the glenoid component on plain X-ray were evaluated.

(Results)

In OA, postoperative JOA score was 85.6 in 2^{nd} TSA and 82.8 in 3^{rd} TSA. Flexion / external rotation angle (deg.) was 122.0 / 40.7 in 2^{nd} TSA and 133.3 / 30.0 in 3^{rd} TSA. Lucent line / loosening were observed in 100% / 0% in 2^{nd} TSA and 20% / 0% in 3^{rd} TSA. In RA, postoperative JOA score was 85.5 in 2^{nd} TSA and 82.8 in 3^{rd} TSA. Flexion / external rotation angle was 115.0 / 38.0 in 2^{nd} TSA and 130.0 / 45.0 in 3^{rd} TSA. Lucent line / loosening were observed in 100% / 10% in 2^{nd} TSA and 7% / 7% in 3^{rd}.

(Conclusion)

In OA, clinical result was not significantly different between 2^{nd} and 3^{rd} TSA; whereas, in RA, better flexion angle was obtained in 3^{rd} TSA. Both in OA and RA, the appearance rate of the lucent line was lower in 3^{rd} TSA. Long-term observation is necessary; however, higher survival rate of the glenoid component is expected in 3^{rd} TSA.

Poster: 97
#721

Clinical Results of TSA and HHR for Old Shoulder Injury

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Introduction

In the old shoulder injury, because of the deformity and the bony defect of a humeral head, and the contracture of the soft tissue, it has a hard time in treatment. The purpose of this study is to investigate treatment results of Total Shoulder Arthroplasty (TSA) or Humeral Head Replacement (HHR) for old shoulder injury.

Materials and Methods

There were 13 shoulders that treated with TSA and HHR were targeted for chronic unreduced shoulder dislocation / fracture dislocation (Group D), Humeral head necrosis after operation of humeral neck

fracture(Group F). There were 7 shoulders (average age 76.4 years old, TSA: 1 shoulder, HHR 6 shoulders, follow up 19.9 months, duration of injury and operation 4.8 months) in Group D. There were 6 shoulders (average age 70.3 years old, HHR: 6 shoulders, follow up 27.2 months, duration of injury and operation 15.8 months) in Group F. Primary operation was IMN (4 shoulders) and plate (2 shoulders) in Group F. Clinical features and surgical results of the 2 groups were evaluated using Japanese Orthopaedic Association (JOA) score, ROM (flex, ER), Modified Neer evaluation.

Results

In both groups it has improved in ROM(flex, ER) and JOA score, but Group D was better than Group F in ROM(flex, ER). JOA score of preoperation/ postoperation was 30.0 points / 78.6 points, ROM (flex) was 52.0°/ 100°and ROM (ER) was –18°/ 17.9°in Group D. JOA score of preoperation/ postoperation was 41.5ã��points / 80.0 points, ROM (flex) was 76.7°/ 86.7°and ROM (ER) was 11.0°/ 18.0°in Group F. There was the significant difference between ROM (flex) and duration from injury. In the Modified Neer evaluation, there were 3 shoulders of Satisfactory and 4 shoulders of Unsatisfactory in Group D, 2 shoulders of Satisfactory and 4 shoulders of Unsatisfactory in Group F. In Group D, it was Unsatisfactory in all cases (3 shoulders) of fracture dislocation and there were 3 shoulders of satisfactory and 1 shoulder of Unsatisfactory in cases of dislocation only.

Conclusion

There is an advantage that TSA/HHR to the old shoulder injury easily to repair the rotator cuff to select smaller humeral head of prosthesis, to remove something of intervention in the joint and to release soft tissue from contracture. Though the improvement of the JOA score and ROM had been seen before operation in most cases, there were a lot of cases of Unsatisfactory in the Modified Neer evaluation. It was thought that there is a limit in the improvement because the disorder before operation is strong.

Poster: 98
#722

CT Evaluation of Pegged Glenoid Component With the 3rd Generation Total Shoulder Arthroplasty

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Purpose

Although total shoulder arthroplasty (TSA) has been demonstrated to be an effective treatment for osteoarthritis (OA) and rheumatoid arthritis (RA), loosening of the glenoid component has been reported as a major complication. Previous report indicated that loosening of keeled component occurred more frequency compared to pegged component. The purpose of this study was to investigate the CT evaluation of pegged glenoid with the 3rd generation TSA.

Methods

Seventeen shoulders were treated by pegged glenoid with the 3rd generation TSA, including eight RA, seven OA, and two OA after necrosis. The mean age was 62 years old (range 49 to 78). Radiolucent line or loosening was evaluated with Yian' CT score.

Result

No additional operations and obvious loosening of glenoid component were found. Total CT score was 3.2 points. There was no significant difference of score between RA ; 3.6 (Range 2 ~ 6) and OA ; 2.8 (Range 0 ~5). There was no clear relationship between CT findings and the clinical finding, but out line peg would be assisted with stability.

Discussion

Compare to previous study, the number of peg would have possibility of stability. Our results were similar to previous study. Better results would be associated with patient selection, cementing technique, and implant design. But we need more cases and long term follow-up.

Poster: 99
#482

Experience of Revision Total Hip Arthroplasty With Direct Anterior Approach in Supine Position

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[Introduction]

Direct anterior approach (DAA) is one of minimally invasive methods in primary total hip arthroplasy; this procedure gift a rapid recovery due to muscle preserving and a precise setting of acetabular component due to stable pelvic positioning in supine position. In our institute, DAA has been introduced to some revision THAs as well as primary THAs. The purpose of this study was to demonstrate the indication and the limitation of the use of DAA for revision THA.

[Materials and Methods]

We reviewed retrospectively 10 hips received revision THA out of 87 hips undergoing revision THA in our institute between 1996 and 2009. The preoperative diagnosis was excessive wear and osteolysis in 3 hips, recurrent dislocation in 4, proximal migration of hemiarthroplasty in 3. There were 1 man and 9 women; their average age at the operation was 67 years. The mean follow-up period was 2.5 years (1-5). We evaluated the clinical and radiographic results including any complications.

[Results]

In all 10 hips, DAA was limited in exchanging acetabular components. Reinforcement was performed in 4 hips; KT plate in 2 hips, metal mesh with several screws in one hip and oblong cementless cup in one hip. Clinically the mean hip score (60 points with Japanese Orthopaedic Association preoperatively) improved to 84 points at the latest followup.Radiographically all acetabular components were stable and retained femoral components were also stable. Transient peroneal palsy developed in 2 hips and intraoperative pelvic wing fracture in one hip. Dislocation, infection and deep vein thrombosis were not seen. Acetabular components were implanted in 38-47°(average: 43°)of abduction angle and in 13-25° (average :20°) of antevered angle with computed tomography.

[Conclusions]

DAA was useful for revision THA with single exchanging acetabular components. With DAA, it may be difficult to removal of residual bone cement in femoral canal, reconstruction of posterior column of acetabulum and circumferential setting of metal mesh with impaction bone grafting. However, a precise setting of acetabular components was possible with DAA due to pelvic stability in supine position.

Poster: 100
#467

Bioactive Bone Cements Containing Micron-Sized Titania Particles: Material and Mechanical Characteristics

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More than 50 years ago, Charnley first used polymethylmethacrylate (PMMA) for the fixation of prostheses, and PMMA bone cements are still widely used. However, PMMA cements cannot bond directly to bone. An intervening soft tissue layer usually exists between the bone and the cement; this occasionally leads to aseptic loosening. Many types of bioactive bone cements have been developed to prevent the aseptic loosening, enabling successful revision surgery. We have focused on composite cements in which bioactive titania (TiO_2) fillers are added to PMMA polymers. At the 22^{nd} Annual Congress of the ISTA, we reported that bioactive bone cements

containing rutile micron-sized titania particles (titania bone cement) have excellent *in vivo* osteoconductivity.

In this study, we evaluated the material (the handling properties and heat evolution curves) and mechanical characteristics (the bending strength and modulus, compressive strength, tensile strength and modulus, bending and tensile fatigue, fracture toughness, and creep properties) of the titania bone cement. Simplex P was used as a control material.

The working time was longer and peak temperature was lower for the titania cement than for Simplex P; in addition, titania cement had a shorter dough time and longer setting time. The mechanical properties of the titania cement were the same or better than those of Simplex P.

A canine total hip arthroplasty (THA) study of the titania cement is currently underway to evaluate the attachment of the implants to the bones and the problems associated with prosthetic joints.

The new titania bone cement exhibited direct bone-bonding activity *in vivo*. In addition, this bone cement was found to have special properties, higher mechanical characteristics, and better handling performance compared to the commercial PMMA cement.

Poster: 101
#990

Usefulness of Intraoperative Measuring Method (Mechanical Axis) in Image-Free Navigation Assisted TKA

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Introduction:

In total knee arthroplasty (TKA), ideal bone cutting, accurate placement of implant and well optimized ligament balance are crucial for long term good clinical results. In our institution, we have utilize the OrthoPilot navigation system (B-Braun Aesculap, Germany) to achieve the above mentioned tasks. In that system, we can measure Mechanical Axis which are values of lower limb characteristic angles (i.e. varus/valgus and flexion/extension) given by angular position of the tibial mechanical axis within the femur frame of reference. The purpose of this study is reporting the measured values with the system , radiological results and clinical outcomes.

Materials and Methods:

Twenty nine patients were enrolled in this prospective case series study between 2008 and 2010 with informed consent of each patients and permission of our institutional ethical board. Twenty seven patients were women and two were men. Averaged age at time of the surgery was 72.9 years. There were 34 knees with osteoarthritis of knee. All of the surgery were cemented TKA with Columbus PS (B-Braun Aesculap, Germany) assisted by the OrhoPilot navigation system. In the operation , before the bone cutting, Mechanical Axis were recorded at each 15 degrees from full extension to 135 degrees of knee flexion. The measured values were again recorded after the implantation of the trial components by the same manner. Plus values mean varus deviation and minus values mean valgus deviation. Clinical outcome were scored by Japanese Orthopaedic Society(JOS) Form for Knee Osteoarthritis before and 1 year after the operation. Radiological results were evaluated following the Knee Society (KS) TKA Roentgenographic Evaluation System.

Results:

Mechanical Axis before the bone cutting were 9.4±2.7(Mean±S.D.), 8.3±2.9, 8.7±3.2, 8.6±3.5, 8.2±4.3, 7.7±4.6, 6.6±4.4, 5.8±5.0, 4.7±4.7 and 3.9±4.2 at full extenson, 15, 30, 45, 60, 75, 90, 105, 120 and 135 degrees of knee flexion, respectively. The values after the placement of trial component were 1.6±1.6, 0.9±1.7, 0.0±1.9, -0.4±1.8, -0.4±1.9, -0.3±2.1, 0.1±2.6, -0.3±2.4, -0.6±2.6 and -1.0±2.9 at each 15 degrees of knee flexion, respectively.(See Figure 1) There were significant improvements of varus/valgus deviation at all angles. JOS score improved from 53.8±9.6 to 76.8±7.5. In KS Roentgenographic Evaluation, α, β,γ and δ angles were 96.2±3.4, 88.9±2.5, 2.5±1.7 and 90.0±2.2, respectively.

Discussion and Conclusion:

In this prospective case series study, we observed significant improvement of Mechanical Axis measured by OrthoPilot navigation system. This values recorded easily at any position during the operation. Mihalko et al. said that the coronal alignment is important in joint wear patterns and longevity. Therefore we think taht this measuring method is useful for case studies or comparisons of each TKA implants, moreover , utilizing this system leads to better clinical outcomes.

Figures

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Figure 1

Poster: 102

#792

Finite Element Study of a Femur With a Total Knee and Total Hip Replacement. Is There a Safe Bony Distance?

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INTRODUCTION:

Insertion of a prosthesis in a femur induces an alteration of the stress distribution [1], which may lead to increased risks for fracture, especially in cases where a Total Hip Replacement (THR) and a Total Knee Replacement (TKR) are simultaneously present. In this numerical study, we investigated how different stem lengths in such a combined replacement configuration affect the stress and strain distributions in the bone. The goal of this study is to identify the eventual safe bony distance between implant stems, which minimizes stress and, consequently, reduces the risk for fracture.

METHODS:

A finite element model of a femur with implanted hip and knee components was developed. The Standard Femur [2] was used to define the bone geometry. Cementless THR (Polar THR, Smith&Nephew, Memphis, TN) and cemented TKR (Legion Revision TKR, Smith&Nephew, Memphis, TN) were virtually implanted according to proper surgical technique. Six stem lengths for the femoral component of the TKR were considered, from 120 mm to 250 mm. Material behavior and friction were chosen according to literature [3-5]. The models were then tested in different physiologically-relevant loading scenarios (gait, sideways falling) and a four-point bending test, [6-8]) using a commercial software (Abaqus 6.10, Dassault Systemes, Paris, France). Stresses and strains at several interprosthestic regions were computed and the maximum strain in the loading (transverse) direction compared with the physiological intact femur.

RESULTS:

For gait, no significant difference in maximal principal strain was noticed between the modeled configurations. All the models of the femur with implants showed strain values which were smaller than the physiological femur (~80%). For sideways falling, our models predicted that higher strains were mostly located around the THR stem tip. In that region, strains for the configurations with intermediate stem lengths were less pronounced and closest to the physiological configuration. While results show strains 2.5 times those of the physiological femur for all replacement configurations during sideways falling, increase of strain is not a risk because it is very low (~40%) compared to the fracture limit that was determined in literature for that specific test. The four point bending test results (Fig. 1) also revealed that the intermediate stem lengths, with a bone distance of 110 mm, were closest to the physiological result.

DISCUSSION:

This study is the first to specifically predict how stem length changes the structural behavior of a femur implanted

with combined TKR and THR prostheses. Results show that stem length affects the interprosthetic strains, which were maximal below the stem tips. In our model the configuration that presents the lowest risk of fracture is the one with a stem length of 190 mm that correspond to the distance between THR and TKR stem of 110 mm.

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Figures

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Figure 2

Poster: 103

#795

Analysis of Cemented and Cementless, Short and Long Stem in a Hinged Total Knee Arthroplasty (TKA): A Numerical Study

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Introduction.

In hinged total knee arthroplasty (TKA) different stem lengths can be used during the surgical procedure. Stems can either be cemented or left uncemented. A numerical model, coupling rigid body kinematics and finite element analysis, was developed to evaluate and compare the effect of the fixation technique and stem length in a hinged TKA. The stress distribution in the tibial bone and micromotions between implant and bone during a lunge and a squat movement were determined.

Methods.

A physiological three-dimensional (3D) tibial bone model was created from computed tomography (CT) images of a left mechanical-equivalent synthetic tibia. A 3D finite element model of a hinged TKA (RT-PLUS Rotating Hinged, Smith&Nephew, Memphis, TN) was implanted in the tibial bone. Four different configurations were considered: a short cementless stem, a long cementless stem, a short cemented stem and a long cemented stem. Stem lengths and sizes were selected based on experimental tests on mechanical-equivalent synthetic tibia specimen. Loading conditions for squat and lunge motions were calculated using a validated musculoskeletal model. Maximum forces acting on the tibial insert during the two analyzed motions were implemented in the finite element models as external forces on the predicted contact areas. Non-linear static simulations were then performed and principal stresses in selected regions of interest (ROI) and micromotions between the implant and the bone were computed and compared.

Results.

Figures 1 and 2 illustrate the distribution of the average principal stress (compressive) for the four analyzed configurations in the two movements as a function of the distance from the tibial cut. For each movement, the most stressed regions were situated around the stem tips. For both movements, the presence of cement reduced the stresses along the bone-cement interface compared to the cementless configuration.

The maximal average compressive stress was higher for the cementless long stem configuration (squat 18.2 MPa – lunge 17.7 MPa) and lower for the cemented long stem configurations (squat 11.5 MPa – lunge 10.1 MPa). Also for the short stem, the cementless configuration showed a higher average compressive stress (squat 13.3 MPa – lunge 14.6 MPa) compared to the cemented configuration (squat 9.5 MPa – lunge 10.4 MPa) in the region situated around the stem tips. However, cemented and cementless short stems showed similar maximal stresses in a region below the stem tip.

Cementless stems show higher micromotions compared to cemented stems (~50%). Long cemented stems result in lower micromotions (~50 μm) compared to short cementless stems with~120 μm.

Conclusions.

The presence of cemented stem induces lower stresses in the tibial bone-stem interface and lower micromotions between implant and bone compared to cementless stem. A short stem shows similar maximal stresses in a region below the stem tip.

Figures

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Figure 3 HYPERLINK "http://app.istaonline.org/figures/1673.jpg" \t "_blank"
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Figure 4

Poster: 104
#661

In Vivo Comparisons of Patellofemoral Kinematics Before and After ADVANCE Medial Pivot Total Knee Arthroplasty

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Purpose:

Advance® Medial Pivot (MP) (Wright Medical) total knee arthroplasty (TKA) had established to replicate normal tibiofemoral knee joint kinematics, medial–pivot knee motion. Design concept of the prosthesis is unique, therefore, the influence on patellofemoral knee joint remains unclear at present. The purpose in this study is to reveal the in vivo patellofemoral kinematics with Advance MP TKA and compare with the pre-operative conditions.

Materials and Methods:

We performed ten ADVANCE MP TKA with the patients of osteoarthritis (OA). At before and one month after surgery, lateral radipgraphs at maximum extension, 30, 60, 90°, and maximum flexion were taken, and patella flexion angle (PF), tibiopatellar angle (TP), and estimated patella contact point to femur (PC) were evaluated, according to previously reported method.

Results:

Pre– and post operative PF at maximum extension, 30, 60, 90°, and maximum flexion were 5.6°±6.1, 24.4±7.6, 46.2±5.5,

66.5±10.9, 89.4±6.5, and 6.1±3.1, 26.7±6.1, 46.8±5.8, 70.8±9.9, 85.0±4.1, respectively. Pre- and post operative TP were 0.4°±4.9, 8.0±5.8, 15.0±6.9, 17.8±8.2, 27.4±9.9, and -0.9±5.1, 10.9±3.7, 16.4±4.9, 19.5±4.8, 21.1±5.4, respectively. There was no statistically significant change between the two groups, however TP post-operation showed different kinematics pattern, compared to that of pre-operation over 90°. Pre- and post operative PC were 0.41±0.06, 0.54±0.08, 0.67±0.08, 0.75±0.07, 0.69±0.13, and 0.51±0.05, 0.61±0.05, 0.65±0.07, 0.60±0.04, 0.63±0.07, respectively. (ratio; normalized with respect to patella length from 0 (apex of patella) to 1 (base of patella)) PC at pre-operation reached its peak at 90°, however its peak was at 60° at one month post-operation. PC at maximum extension at post-operation was significantly higher, compared to that of pre-operation.

Conclusions:

The results in this study indicated that ADVANCE MP TKA changed patellofemoral joint kinematics, compared to that of before surgery. Evaluation at early post-operation is the limitation in this study, however we consider that the result in this study might be one of the key to resolve the kinematic features of this prosthesis.

Poster: 105
#858

Blood Metal Ion Levels After Large Head Metal-on-Metal THA With ADEPT Hip System

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Introduction:

Although metal-on-metal THA is in widespread use, several investigators reported wear and corrosion of the bearing surfaces and the subsequent increase in serum metal ion levels. The ADEPT Hip System have large head Metal-on-Metal implant (ADEPT V40 modularhead) manufactured by the same method as Birmingham Hip Resurfacing (BHR) system. There have been no studies of the blood levels of metal ions after implantation of the ADEPT Hip System with conventional stems. The purpose of this study was to evaluate the factors associated with the ion levels when using this system and to compare with previously published ion levels from BHR system.

Methods:

We investigated 19 presenting patients implanted with unilateral ADEPT hip system between October 2007 and April 2010. The blood levels of cobalt (Co) and chromium (Cr) ions were analysed with each patients at a minimum of 12 months after surgery (averaged 24.4 months after surgery). Radiographs and computed tomography (CT) were taken to measure the component alignment and to confirm the exsist with a pseudotumor. Harris hip score and UCLA activity scores were also analyzed. Speaman's rank correlation was used to identify any significant relationships between blood metal ion level and the factors might influence it.

Results:

All patients had improvement in Harris hip score from preoperative score (63.9) to postoperative score (91.6). CT showed no pseudotumors. The mean values for Co and Cr ions were 2.5 μg/l and 2.7μg/l. There was a very high correlation between the levels of Co and Cr ions ($p<0.001$, $r=0.83$). The blood levels of Co and Cr ions were inversely related to the length of time from the surgery (Co; $p=0.034$ $r= -0.49$, Cr; $p=0.018$, $r= -0.55$). No significant correlation was found between the levels of metal ions and head size, acetabular cup alignment, combined anteversion with the femur component, Harris hip score, UCLA activity scores, and body weight.

Discussion & Conclusion:

There have been no studies of the blood levels of metal ions after implantation of the ADEPT Hip System. The mean value for Co ion (2.5 μg/l) in this study was slightly higher than the range (1.1 to 2.4 μg/l) reported in the literature about BHR system. The value was below 7 μg/l suggested by the Medicines and Healthcare Products Regulatory Agency (MHRA) as a risk (2010 U.K.). Metal ions relatively decrease over one year after surgery, the blood levels of Co and Cr ions after implantation of the ADEPT Hip System would be acceptable enough. This system had a good results without any allergic reaction. Further longer follow up should be needed to clarify trends in blood metal ion level and allergic reaction as pseudotumor in the future.

Poster: 106
#1108

Pedicle Screws Can Be 4 Times Stronger Than Lateral Mass Screws for Insertion in the Mid-Cervical Spine: A Biomechanical Study

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Objectives:

To compare pullout strengths of pedicle screws and lateral mass screws inserted into cervical vertebrae (C3-6) after a period of cyclic loading in order to determine the limitation of lateral mass screw for cervical fixation.

Summary of Background Data:

In the clinical situation pedicle screws are more commonly used in the lower cervical spine and lateral mass screws in the upper-middle cervical spine. However none of the previous studies tested the pullout strengths of cervical pedicle and lateral mass screws after the screws had been subjected to periods of fatigue loading in two planes: flexion/extension as well as torsion (ie axial rotation) for the upper-middle cervical spine.

Methods:

32 vertebrae (C3 to C6) were harvested from eight spines. For each vertebra, one side was randomly chosen to receive a pedicle screw and the other side a lateral mass screw. The pedicle or lateral mass screws inserted into the first 16 vertebrae were cyclically loaded to simulate torsion: cyclic loading ±75 N at 1 Hz applied for 500 cycles. The pedicle or lateral mass inserted in the remaining 16 vertebrae were cyclically loaded to simulate flexion/extension of the spine: cyclic loading, ±75 N at 1 Hz applied for 500 cycles. At the end of the cyclic loading each screw was pulled out along its long axis.

Results:

The main results to come from this experiment are: 1) Overall the mean pullout strength of the pedicle screws was significantly higher than the mean pullout strength of the lateral mass screws; 2) Looking at the individual vertebral levels (C3-6), the difference in the mean pullout strength between the pedicle screws and the lateral mass screw for each vertebra in both the flexion/extension group and in the torsion group was statistically significant at all levels ($p<.05$), with the difference being more pronounced in the torsion group.

Conclusions:

Not forgetting the potential risks of inserting pedicle screws in cervical vertebrae, pedicle screws are a better biomechanical choice than lateral mass screws for cervical fixation at all levels C3 through to C6. Pedicle screws can offer up to four times the pullout strength of lateral mass screws when the two types of screw fixation are subjected to cyclic loading to simulate torsion (ie axial rotation) motions of the spine.

Poster: 107
#726

Fondaparinux Prevents DVT, but Not PE, Following TKA With MDCT Analysis

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INTRODUCTION:

Pulmonary embolism (PE) and deep-venous thrombosis (DVT) are serious complications after total knee

arthroplasty (TKA). Various techniques may be used to assess PE and DVT, for example, doppler sonography, venography, magnetic resonance angiography, computed tomography (CT) venography. CT has become a major diagnostic tool in detecting PE. It is minimally invasive and permits direct visualization of the clot instead of indirect evidence (swelling and edema of the lower extremity). We used a 64-slices multi-detector row CT (MDCT) which can detect PE and DVT at one-time injection of contrast medium for 1 min. The first purpose of this study was to assess the prevalence of PE and DVT after TKA. Fondaparinux is a synthetic pentasaccaharide and highly selective inhibitor of activated Factor Xa. The second purpose of this study was therefore to assess the prevention of PE and DVT by using fondaparinux after TKA.

METHODS:

We recruited 72 consecutive patients who underwent primary total knee arthroplasty (TKA) between May 2006 and March 2009. The criteria for exclusion from the study were: renal insufficiency; use of anticoagulations; past history of PE, DVT and asthma; allergy of contrast medium; and preoperative blood D-dimer levels over 2.0 μg/ml. In this study, we studied 88 TKA (72 patients). There were 63 women and 9 men. The average age at operation was 75.0 years (range, 58-94 years). The preoperative diagnosis was osteoarthritis in 64 patients with 79 TKA, rheumatoid arthritis in 8 patients with 9 TKA. All TKA were performed by two senior authors (H.I. and Y.M.) at the author's institution. Forty-four knees in the non Fondaparinux (nonFP) group equipped with a venous foot pump (VFP) on both legs until walking, and 44 knees in the FP group that received a subcutaneous injection of Fondaparinux with a venous foot pump were not significantly different with respect to age, sex, weight and body mass index (BMI). All CT examinations were performed by 64-slices MDCT. At day 7, all patients underwent combined MDCT pulmonary angiography and CT venography of lower limbs. PE and DVT were detected by a radiologist. Furthermore, D-dimer levels were also measured postoperatively at day 7. In our institution, plasma D-dimer levels were measured by latex technique. The effect of clinical prothrombotic risk factors on PE or DVT (gender, age, BMI, diagnosis, between or postoperative bleeding, duration of operation) was analysed by multivariable analysis. The numbers of D-dimer levels (cutoff value of 8.0 μg/ml) were compared between the patients with or without PE and DVT with use of Chi-square test. Computer software (SAS software version 9.1, SAS Institute, Cary, NC.) was used for statistical analysis. Levels of significance of 95% or better were accepted.

RESULTS:

In the nonFP group, DVT was revealed in ten patients (22.7%), and PE occurred in five patients (11.4%). In the FP group, DVT was revealed in four patients (9.1%) and PE occurred in six patients (13.6%) The incidence of DVT in the FP group tended to be less than the nonFP group ($p = 0.08$). All patients were asymptomatic and not fatal. Bleeding occurred in 7 patients (15.9%) in the FP group, whereas there was no bleeding in the nonFP group. The difference in age, sex, weight, BMI, blood loss with or without fondaparinux was not statistically significant.

DISCUSSION:

CT is recognized as a major diagnostic tool . Philipp et al. [2] reported that there was no difference in the ability to detect DVT of the pelvis and thighs between four-slice MDCT and Doppler sonography. Therefore, only CT can detect PE and DVT simultaneously, which is a most advantageous feature, but has the disadvantages of cost and radiology exposure. The latter was estimated to be 100 mGy. Mechanical prophylaxis with a VFP prevents thromboembolic disease after major orthopedic surgical procedures [3]. Fitzgerald et al. [4] reported that the rate of DVT after TKA was very high (33.5%). Compared with previous reports, the prevalence of DVT and PE detected by MDCT in our institution was very low due to an accelerated rehabilitation program and fondaparinux. Shiota et al. [1] reported that the most sensitive (95%) and specific (92%) cutoff level of D-dimer in TKA was 10.0μg/mL on postoperative day 7. In the present study, the cutoff level of D-dimer was 8.0 μg/mL. This cut-off level exhibited high sensitivity (86.7%), but low specificity (45.2%) **(Fig. 1)**. So we concluded that under 8 μg/ml of D-dimer level on post operative day 7 appears to be an indication of the no occurrence of DVT after TKA. But D-dimer levels were not an indication of PE after TKA. Finally, we belive that MDCT is a most useful tool for detecting DVT and PE despite of a cost and exporesure.

Figures

Poster: 108
#725

Fondaparinux Compared With Enoxaparin for the Prevention of Venous Thrombosis in Total Hip Arthroplasty.-Randomized Controlled Trial-

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Purpose

Deep venous thrombosis (DVT) and pulmonary embolism (PE) were serious complications after total hip arthroplasty (THA). The purpose of our study is to compare fondaparinux with enoxaparin for prevention of DVT and PE using enhanced multi-ditector row CT postoperatively.

Materials and methods

From Febururly 2010 to May 2011, We randomly assigned 100 consecutive THA patients aged less than 80 years old . The criteria for exclusion from the study were: renal insufficiency, past history of PE or DVT, use of anticoagulations and asthma, allergy of contrast medium. They received postoperative subcutaneous injections of either 1.5mg fondaparinux once a day, or 20mg enoxaparin twice a day, for ten days between 3 and 13 days posoeratively. At day 7, patients underwent combined MDCT pulmonary angiography and indirect CT venography of lower limbs, analyzed by a radiologist. We also compared with mean estimated blood loss which is calculated from Hb in day 1 and day 7, and the incidence of major bleeding.

Results

Demographic databetweem two groups was not significant different. We found DVT or PE in four cases (8%) in fondaparinux group, nine cases (18%) in enoxaparin group.(Fig.1) More than two times incidence of DVT or PE in Enoxaparin group was observed, but the difference was not significant (p=0.13). (Mean calculated estimated blood lossï¼EBLï¼ was 437ml in fondaparinux group, 364ml in enoxaparin group. (Fig.2) There were two major bleedings (4%) in fondaparinux group, and three (6%) in enoxaparin group.

Discussion

We found Fondaparinux showed 44% reduction rate with respect to an incidence of DVT or PE compared with Enoxaparin. Previous reports using fondaparinux (2.5mg) showed more risk of major bleeding. Fondaparinux (1.5mg) is more effective than Enoxaparin and safe as same as Enoxaparin. We conclude that the usage of Fondaparinux (1.5mg) is the best option for the prevention of thrombosis after THA for Japanese population in our hands.

Figures

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Figure 4

Poster: 109
#685

In Vivo Kinematics of Three-Component Mobile-Bearing Total Ankle Arthroplasty. a 3D-Evaluation Using Fluoroscopic Imaging

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Background:

High complication rates and low survivorship are still problematic in total ankle arthroplasties (TAA), as compared to total knee and hip arthroplasties. This could primarily be due to implant loosening and subsidence induced by excessive articular contact stress during ankle motion, especially in gait cycles. The purpose of this paper was to study in vivo kinematics of a three-component mobile-bearing TAA by 3D-evaluation of fluoroscopic imaging of ankle motion.

Patients and Methods:

Three ankles (3 patients) implanted with a three-component mobile-bearing TAA (FINE Total Ankle System, Nakashima Medical, Japan) were studied. Fluoroscopic images were obtained while each patient moving the implanted ankle without weight-bearing, maximal dorsiflexion and plantarflexion, as well as while walking with full weight-bearing on the implanted ankle. Thereafter tibio-talar motion was analyzed by 2D/3D registration technique, a reproduction method of the spatial position of each component in TAA from single-view fluoroscopic images by use of computer-assisted design (CAD) models. We evaluated the dorsi-/plantarflexion angle, internal/external rotation angle and inversion/eversion angle between the components.

Results:

Average tibio-talar motion without weight-bearing on the implanted ankle was 15.0 ±11.5° of plantarflexion and 12.2±10.0° of dorsiflexion, with average internal/external rotation arc of 3.0±1.7° and average inversion/eversion arc of 3.2±0.8°. On the other hand, average tibio-talar motion in gait cycles with full weight-bearing on the implanted ankle was 4.5±16.6° of plantarflexion and 12.9±8.6° of dorsiflexion with average internal/external rotation arc of 9.1±4.7° and average inversion/eversion arc of 5.9±2.9°.

Discussion:

Increased internal/external rotaion as well as inversion/eversion were observed in gait cycles with full weight-bearing on the implanted ankle, suggesting that three-component mobile-bearing TAA could allow high demand of mobility other than dorsi-/plantarflexion in gait cycles. Further investigation should be necessary in more number of cases not only in this implant but also in other types of TAA.

Poster: 110
#432

Impaction Bone Grafting for Femoral Revision Hip Arthroplasty With Exeter Universal Stem by Well-Trained Surgeons in Japan

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Introduction:

Since 2000 the training course to learn about theoretical background and surgical skills on primary and revision total hip arthroplasty using polished tapered collarless Exeter Universal stem have been organized in Japan. To assess the effectiveness of the educational impact on femoral revision technique of Japanese experienced surgeons, we performed a retrospective study on clinical and radiographic results of 99 femoral revisions in 97 patients with impaction bone grafting at least two years after the surgery.

Patients and methods:

Between February 1997 and December 2007, we performed 103 femoral revisions with impaction bone grafting technique using Exeter Universal stem in 97 patients. One patient died because of unrelated disease within two years after the surgery, and three patients were lost from follow-up, so we investigated radiographic findings and clinical records more than two years after the surgery in 99 hips of 93 patients. All operations were performed for femoral stem loosening with periprosthetic bone defect. The average age of the patients at the surgery was 66.3 years (36-84 years) and the average follow-up period was 5.2 years (2-13 years). For clinical assessment, the

Merle d'Aubigné and Postel hip score was assessed preoperatively and at the final follow-up. Intra- or post-operative fractures were recorded. The radiographs were evaluated for subsidence and for the position of radiolucent lines in the femur. Survival curve was estimated with use of the Kaplan-Meier method. The primary end points were any type of femoral re-operation, post-operative femoral fractures, any stem removal, and aseptic stem loosening of the stem at five and eight years.

Results:

According to the Endo-klinik classification, the femoral bone defects were classified as grade I in 4 hips, grade II in 37, grade III in 42, and grade IV in 16, respectively. The mean Merle d'Aubigné and Postel hip score improved from 9.0 points (1-17 points) to 15.2 points (3-18 points) at the final follow-up. Intra-operative fractures or perforations occurred in 20 hips and post-operative fractures in 5 hips. All 5 post-operative fracture cases were revised, or fixed with metal or allogenic bone plates successfully. Including these 5 operations for post-operative ftactures, re-operations for femur were undertaken in 9 hips, and the others were stem removal for infection in 2 hips, and cement-in-cement re-implantation for acetabular problems in 2 hips, respectively. The Kaplan-Meier survival analysis revealed that the survival rate with any type of re-operation for femoral side as the end point was 91.1% at five years and 88.9% at eight years. The survival rate with post-operative femoral fractures as the end point was 94.8% at five and at eight years. The survival rate with any stem removal or exchange as the end point was 95.3% at five years and 93.1% at eight years. The survival rate with aseptic stem loosening of the stem as the end point was 99.0% at five and at eight years.

Conclusion:

The present study showed encouraging and the bench mark mid-term result of impaction bone grafting for femoral revision arthroplasty by experienced surgeons in Japan.

Poster: 111
#951

Surgical Approach Yields No Long Term Functional Differences After TKA in Sit-Stand-Sit Tasks

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Introduction

The sit-stand-sit task (SSS) is one of the most demanding lower extremity activities of daily living. In an elderly population, the ability to rise from a chair is essential for independent living. Since a stated goal of total knee arthroplasty (TKA) is to restore activities of daily living, it is important to study the results of this intervention during demanding tasks. Surgeons can utilize different surgical approach techniques for exposure when performing TKA. Onstot et al. (2010) showed that surgical approach did elicit differences in knee kinetics during SSS following short term recovery. This study quantifies kinetic and kinematic differences during a SSS task after long term patient recovery following TKA with four different surgical approaches.

Methods

95 subjects volunteered to participate in the study and signed an IRB approved informed consent prior to testing. The subjects were prospectively randomized to one of four surgical approach groups, mini-midvastus (MV), mini-subvastus (SV), mini-parapatellar (MP), and standard parapatellar (SP). Motion data was captured using a ten-camera motion capture system (Motion Analysis Corp., Santa Rosa, CA). Three-dimensional force data were recorded for each limb using two floor embedded force platforms (AMTI Inc., Watertown, MA). A stool with no arm rests was adjusted to the height of the patient's horizontal knee axis. Patients were asked to sit on the stool with feet a comfortable distance apart and one foot on each force platform. Each patient was asked to rise from and descend onto the stool five times without using their arms for assistance, pausing between the completion of one motion and initiation of the next. Data were collected using EVaRT 5 software (Motion Analysis Corp., Santa Rosa, CA) and analyzed using OrthoTrak 6.2.8 (Motion Analysis Corp., Santa Rosa, CA) and MatLab software (The Mathworks Inc., Natick, MA). Statistics were run using SPSS 14.0 (SPSS Inc, Chicago, IL).

Results

At the two year time point there were no statistical differences in kinetic, kinematic or temporospatial parameters

between groups. However, a trend toward increased knee and ankle power absorption with decreased hip power absorption was noted in the MV group at the two year time point. A similar trend was noted in STSU but the reduction in hip power was compensated at the knee only.

Discussion

As previously stated, differences were noted between approach groups between 2 months and one year after TKA during the SSS tasks. At the two year time point, no statistical differences remain between approach groups. The increased knee power absorption in the MV group occurs predominantly during the STSD task, when the knee flexors are acting through eccentric contraction to slow descent into the chair. There were no differences in peak knee or hip moments during the task suggesting that active muscle force generation is not a significant contributing factor to the observed trends. This research indicates that although differences are seen during early to mid-term recovery, the four surgical approaches provide similar long term functional results in patients performing demanding ADLs such as the SSS task.

References

Onstot, B.R., Jacofsky, M.C., Jacofsky, D.J. *Proceedings of the 56th Annual Orthopaedic Research Society Meeting, 2010.*

Poster: 112
#480

The Accuracy of Digital Templating in Predicting Implant Sizes and Leg Length Corrections in Hip Arthroplasty

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Background:

Pre-operative preparation for primary hip arthroplasty is of paramount importance to produce effective clinical results for patients with osteoarthritis. Digital templating programmes are used by orthopaedic surgeons pre-operatively to measure the size of cup and stem implants required in addition to measuring leg length discrepancies (LLD) and required changes in offset of the hip joint.

Aims:

To investigate the relationship between templated and used implants in a sample of patients undergoing primary hip arthroplasty and analyse the accuracy of templating, its usefulness in predicting the size of implants required and measuring the required changes in leg length intra-operatively.

Methods:

A retrospective analysis to compare pre-operative templated radiographs and post-operative check radiographs of 57 consecutive patients having primary hip arthroplasty by a single consultant orthopaedic surgeon. Measurements of femoral and acetabular components, femoral offset and LLD pre-operatively were compared with actual implants used and intra-operative LLD measurements in addition to measurements of post-operative LLD on radiographs by two authors.

Results:

Using 2-tailed Pearson's correlation testing, there was significant agreement in the size of templated and used femoral components (49 of 57 in total agreement, $p<0.01$), acetabular components (27 of 57, $p<0.01$) and femoral offset (35 of 57, $p<0.01$). Pearson's correlation between templated LLD and intra-operative correction was at 0.778, ($p<0.01$). There was more significant correlation in Hybrid hip replacements in comparison with cemented hip replacements, although there was no significant difference to whether a contralateral hip replacement already existed or not.

Conclusion:

Pre-operative templating in hip arthroplasty significantly correlates with intra-operative procedures with regards to implant sizes and corrections of LLD. We would recommend use of such templating programmes prior to arthroplasty as an adjunct to improve the efficiency and accuracy of the operation.

Poster: 113
#675

Comparison of Simultaneous Bilateral Total Hip Arthroplasty and Staged Bilateral THA -Its Safety and Economics-

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Purpose:

The purpose of this study was to compare the results of simultaneous bilateral and staged bilateral total hip arthroplasty (THA) in terms of its safety and economics.

Materials and Methods:

From January 2004 and November 2009, there were 204 patients (408 hips) who had simultaneous or staged bilateral THAs by a single hip surgeon. They were further divided into two groups: (1) simultaneous bilateral patients (Group A) (2) staged bilateral patients (Group B). For the evaluation of clinical outcome, we checked HHS, WOMAC score and for the ragiographical outcome, we evaluated cup and stem position and implant migration and loosening. We compared amount of blood loss, needs for transfusion and perioperative morbidities and compared the total amount of hospital fee for the economics.

Results:

Preoperative age, gender, BMI, ASA status showed no significant difference between the two groups. The clinical outcomes in terms of HHS and WOMAC score showed no significant difference at the last follow-up. The incidence of perioperative morbidity in group A (146 patients, 292 hips) was 2%(3 patients) including pleural effusion, stress hyperglycemia and duodenal ulcer. In group B (58 patients, 116 hips), 1 patient showed symptomatic deep vein thrombosis. In group A, 2 patients (1.4%) showed postoperative superficial infection, 1 patient deep infection and 1 patient dislocation. In group B, 1 patient (1.7%) underwent postoperative deep infection. In group A the average hospital stay was 14.6 days (SD±8.2 days) and in group B 23.7 (SD±5.2 days), and it showed significant difference ($p<0.001$). The group A showed more blood loss than group B (886 cc vs 472 cc, $p<0.001$) at the time of unilateral THA, but the total amount of blood loss after staged operation showed no significant difference (886 cc vs 929 cc, $p>0.05$). The average blood transfusion showed no significant difference between two groups (2.86 vs 2.37 unit, $p>0.05$). In the total hospital cost, group B showed 1.2 times higher than group A.

Conclusion:

In terms of perioperative morbidity, postoperative complications, there was no significant difference in simultaneous bilateral THAs and staged bilateral THAs and simultaneous bilateral THAs were more beneficial in economic aspect.

Poster: 114
#1021

Morselized Autografting for Superolateral Acetabular Roof Defects in Primary Total Hip Arthroplasty for DDH With Cementless HA Coating Cup

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Objective.

Bulk femoral head autografting is commonly used to reconstruct superolateral acetabular roof defects in primary total hip arthroplasty (THA) for developmental dysplasia of the hip (DDH). However, the surgical procedure is somewhat complicated. Morselized autografting is a simple and easy procedure to fill the defect, and also facilitates remodeling. However, its risk of mechanical failure, long-term results, and graft incorporation to the implants are not known. The purpose of this study was to assess the outcome of using primary THA with a cementless HA coating cup and morselized autograft to augment acetabular roof defects in patients with DDH.

Methods.

A total of 173 hips in 155 DDH patients with moderate to severe acetabular roof defects reconstructed by morselized autograft with HA-coated cups were included in this study. All cups were press-fitted with 1 or 2mm under reaming and subsequently fixated with 1 to 3 screws. Morselized autografts were obtained from the reamed bone, and used to fill the defect as much as possible. All patients were permitted full weight bearing immediately after surgery. Magnitude of the acetabular roof defects was evaluated by socket center-edge angle (Sugano, 1995): 31 hips were between -10 and 0 degrees, 49 hips were between 1 and 10 degrees, and 93 hips were between 11 and 20 degrees. No patient was lost during follow-up. Mean follow-up duration was 48 months (range, 12-120 months).

Results.

All cups were stable and obtained bone ingrown fixation to the host bone even thogh host bone coverage was around 0 degrees. Reorientation of the bone trabeculae in the graft was observed within 12 months in all hips Radiolucent lines at the graft-cup interval were seen only in 9 hips. HA coating cup surfaces appeared to be osteointegrated to the graft bone in most cases.

Conclusion.

HA coating cups with morselized bone grafting showed excellent stability and sufficient bone stock recovery. Remodeling of the graft was speedy, and bone ongrowth appeared to be fixated at the graft-implant interval.

Poster: 115
#508

Strict Component Positioning Is Necessary in Hip Resurfacing

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Hip resurfacing provides many advantages compared with conventional total hip arthroplasty (THA), and then it has been recently surgical options in younger and more active patients with osteoarthritis and osteonecrosis of the femoral head (ONFH) in Asia. Excellent midterm results of this technique have been reported. However, femoral neck preservation that is one of the most attractive points in hip resurfacing adversely decreases head-neck ratio and results in postoperative impingement (**Figure. 1**) and impair range of motion (ROM). The Asian lifestyle requires a larger ROM than that in Western countries and adequate investigations to elucidate the optimal component alignment in hip resurfacing to avoid impingement in these daily activities is necessary.

We evaluated three discrete analysis; 1) ROM after hip resurfacing implanted with various component orientations, 2) the relationships between anatomical factors and maximal ROM and 3) optimal acetabular component orientations (safe zone) to avoid impingement in Japanese daily activities using computer simulation models of 8 Japanese ONFH patients (mean age: 49.5 years) without morphological abnormalities in various acetabular component orientations including three patterns of inclinations (20° - 40°) and eight patterns of anteversions (0° - 35°).

ROM after hip resurfacing varies among patients. In all 192 simulations, flexion motion of more than 90° was achieved in 89 simulations (46.4%) and only 47 simulations (24.5%) allowed flexion of more than 100°. Femoral

anteversion, neck-shaft angle, and cup anteversion significantly correlated with maximal flexion angle ($P = 0.012$, 0.013, and 0.001, respectively). And combined acetabular and femoral anteversion was significantly correlated with both maximal flexion and extension angle ($P < 0.001$ and $P = 0.012$). Safe zone of the acetabular component to fulfill our criteria of ROM in daily activities (90 or 100° in flexion, 20° in extension, 30° in abduction, 20° in adduction, 30° in external rotation, and 60° in internal rotation) depended on the patient's morphological features and there was no safe zone in 3 (37.5%) of 8 patients. It was difficult to evolve simple mathematical formulas about the acetabular component alignment such as those recommended in THA as many factors affect the impingement and ROM in hip resurfacing.

Impingement after hip resurfacing affects not only impingement and postoperative ROM, but also results in loosening of the component, pain, release of metal debris, and femoral neck fracture. Surgeons should realize postoperative impingement seems to occur relatively frequently in cases of hip resurfacing in which the native femoral neck is preserved. Greater care should be taken in hip resurfacing than in conventional THA with regard to rigorous preoperative planning, patient selection and accurate component positioning using surgical tools, such as navigation.

Figures

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Figure 1

Poster: 116

#530

Validation of a Redlux 3D Artificial Hip Profiler for Linear and Volumetric Wear Analysis

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Introduction

Wear of artificial hip joints are commonly measured using CMM and roundness methods which are time consuming and either give volumetric wear (CMM) or linear wear depth (Roundness machine). Redlux 3D profiler has been developed to generate 3-dimensional profiles of the bearing surfaces of artificial hip joint devices. It combines benefits of CMM and roundness methods allowing for high-resolution and large area coverage profiles to be created in minutes, providing both linear wear and volumetric wear values. The aim of this study was to validate the accuracy of the Redlux machine against the well-established gravimetric and roundness wear analysis methods.

Materials and Methods

Two validation methods were used in this double blinded study. Volumetric wear validation was performed using 4 CoCrMo modular heads (Smith & Nephew Orthopaedics, UK), two 36mm and two 46mm heads. Wear patches of various depths and sizes were generated on the bearing surface of the heads. Wear volume was first measured gravimetrically using a precision balance (Mettler Toledo xp504), and then measured with a Redlux machine.

Linear wear depth validation was performed using 5 explanted CoCrMo modular heads (Smith & Nephew Orthopaedics, UK) with *in vivo* time ranging from 1 to 6 years. Each modular head was measured using the Talyrond 290 roundness machine and Redlux 3D profiler.

The differences between the redlux results and the gravimetric/roundness results represent the accuracy of the redlux method.

Results

Table 1 compares the maximum linear wear depths of 5 explanted BHR modular heads using a Talyrond 290 roundness machine and Redlux 3D profiler. The average difference between the two methods was 0.08 ± 0.39(Std) μm. Table 2 compares the volumetric wear results of 4 modular heads using gravimetric and Redlux

methods. The average difference between the two was 0.01 ± 0.01(Std) mm^3.

Discussion

Wear is one of the most important factors affecting the long term clinical outcome of a hip joint device. The Redlux 3D profiler has advantages over conventional methods for wear analysis including CMM and roundness. It has the ability to generate high resolution images with large surface coverage allowing for the entire bearing surface to be scanned within minutes. It provides both wear depth and wear volume. This study shows that the Redlux machine has an accuracy of 0.08 ± 0.39(Std) μm for linear wear and 0.01 ± 0.01(Std) mm^3 for volumetric wear. The accuracy of the Redlux measurement is considered to be satisfactory.

Figures

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Figure 1

Poster: 117
#784

Three-Dimensional Motion of Finger Joint: A Cadaveric Study

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INTRODUCTION

A number of articles discussed the anatomy and function of index finger. Despite a considerable increase in knowledge about the index finger, the motion of finger bone remains incompletely understood. In the past reports, surface optical marker has been used to investigate the index finger joint motion generated by individual extrinsic muscles. In this study, we directly fixed the optical marker to the bone, and calculated the helical axis (HA) of each joint.

MATERIALS AND METHODS

Four fresh-frozen cadaver hands were used. We exposed seven tendons (FDP, FDS, EDC, EIP, Lum, IOD, IOV) that contribute to the index finger motion, and set strings so that we can pull each tendon independently by our computer-controlled apparatus. Seven tendons except Lum were pulled to make the reference position. Each extrinsic muscle tendon was pulled by 2mm per second separately. The flexors were pulled from full extended position until the index finger become fully flexed, while the extensors were pulled from full flexed position until the index finger become hyper-extended. Three optical markers with diameter of 4mm were fixed to distal phalanx, middle phalanx, proximal phalanx and the base of the custom-built fixation apparatus, respectively. The trajectories of the optical markers were recorded by a motion capture system. Computed tomography (CT) images were also obtained for the markers and bones. Surface geometries of the markers and bones created from the CT images were fit into the marker trajectories obtained from the motion capture data to reconstruct the bone motion.

RESULTS

In the reference position the index finger was adducted to the ulnar side. As the FDP was being pulled and the metacarpophalangeal (MP) joint was being flexed, the index finger gradually abducted until the flexed middle phalanx and the metacarpal bone overlap each other from the palmar view (Fig. 1). HA of each joint was calculated from this three-dimensional bone motion data. As the index finger was flexed, the HA of MP joint inclines with the increase in its joint angle (Fig. 2).

DISCUSSION

We presented a new technique to analyze index finger bone motion generated by extrinsic muscles. The optical marker fixed on each bone could indicate the bone motion without skin movement artifact. In the reference position, the index finger was adducted because of gravity. As the MP joint was flexed, the ligament of MP joint was tightened, and the index finger abducted to the radial side. The mechanical properties of the cadaveric tissues

may be different from live tissues. Also, the tendons were pulled with 2 mm per second to achieve stable measurement; however, the velocity might be different in living human. Despite of these limitations, we consider the proposed technique and result of this study will be useful for understanding index finger joint motion.

Figures

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Figure 4

Poster: 118
#667

Analysis of Trochlear Inclination Angles in Normal and Dysplastic Knees

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Introduction

The morphology of the trochlea is highly variable and impacts trochlear component position in “inlay” style designs in patellofemoral arthroplasty (PFA). This study characterizes the patellofemoral trochlear inclination angle and highlights the reason for patellar maltracking that is common with inlay style PFA designs.

Methods

Magnetic resonance images of 329 consecutive knees (146 male, 183 female) were evaluated in normal (n=279) and dysplastic (n=50) patients. A standardized trochlear inclination angle (TIA) was measured by two independent (orthopedic and radiology) reviewers. Two angles were measured for each knee: one measurement included articular cartilage, and the other was an angle subtended from the subchondral bone (i.e. excluded cartilage surface). Numbers of patients in subgroups met pre-study power analysis requirements. Student’s t-test was used for statistical analysis.

Results

The average TIA in normal knees was 11.4 degrees internal rotation (range, 6 to 20), while the average angle in dysplastic knees was 9.4 degrees (range, 4 to 15). These differences between normal and dysplastic knees was significant, ($p<0.0001$); however, regardless of morphotype, the mean TIA was internally rotated. Patients with dysplastic knees were significantly younger than controls (36.9 vs. 50.5 years, $p<0.001$). The average angles in male patients (11.3 deg) and female patients (10.9 deg) did not differ significantly ($p=0.14$). The average angles in patients less than 50 years of age (n=164) did not differ significantly from patients greater than 50 years (n=165) (10.9 deg vs. 11.3 deg; $p=0.15$); when excluding cartilage, however, a significant difference arose ($p=0.01$).

Discussion and Conclusion

The trochlear inclination angle is different for dysplastic and normal knees; however, most tend to be internally rotated relative to the femoral anteroposterior axis. Positioning a trochlear component in PFA parallel to the articular surface of the native trochlea would result in internal rotation malposition, predisposing to patellar subluxation after PFA.

Poster: 119
#668

Efficacy and Cost Analysis of Saline-Coupled Bipolar Sealing in Revision Total Hip Arthroplasty for Infection

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Introduction

Blood conservation with saline-coupled bipolar sealing devices in primary total hip arthroplasty (THA) has had mixed results. Moreover, the utility of these devices has not been investigated in the setting of infected THA when conventional blood management methods such as cell salvage cannot be used. New technologies, in addition to being clinically effective, must be cost effective in order to gain widespread use. The purpose of this study is to evaluate the efficacy and cost effectiveness of a saline-coupled bipolar sealing device in infected THA.

Methods

We performed a retrospective single-surgeon case-matched study of 56 consecutive patients undergoing surgery for infected revision THA. Results with use of a saline-coupled bipolar sealing device were compared to a control group of conventional electrocautery. Groups were matched for gender, BMI, ASA classification, and surgery type. The groups were compared for multiple variables including total blood loss, transfusion requirements, operative time, discharge hemoglobin, and length of stay.

Results

No difference in blood loss or transfusion requirements was observed between the two groups. Operative time and length of stay were significantly lower (158.3 ± 51.8 minutes vs. 201.9 ± 73.7, $P = 0.030$; and 6.6 ± 5.6 vs. 7.1 ± 6.3 days, $P < 0.042$), and discharge hemoglobin was higher in the bipolar sealer group (9.4 ± 1.0 vs. 8.5 ± 1.0 g/dL, $P = 0.016$). This translated to an average net savings of approximately $2,556 per case. There were no reoperations or complications associated with the use of this device.

Discussion and Conclusion

While use of a saline-coupled bipolar sealing device did not significantly decrease blood requirements in patients undergoing treatment for infected revision THA, reductions in operative time and length of stay economically justify its consideration in these cases.

Poster: 120
#589

Measurement of the Component Gap Before Final Resection of the Femur in Total Knee Arthroplasty

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Introduction:

Although, the purpose of the surgical procedure of total knee arthroplasty (TKA) is to make good ligament balance and adequate gap space in extension and flexion position of the knee, the gaps after bone resection (bone gap) are different from the gaps after trial component setting (component gap) because of the thickness of the posterior part of the femoral component and the tension of the posterior capsule. During surgery, the extension and flexion gaps are estimated by checking the bone gap. Component gap can be checked only after complete bone resection. This is the final step of the surgery so it is difficult to change the gaps after checking the component gap even if the result is not acceptable. To resolve this problem, “pre-cut trial component” of the femur was developed. With this specially made trial component, it became possible to check the component gap before final bone resection of the femur.

Materials and methods:

The pre-cut trial component is composed of usual distal part and 4 mm thickness posterior part of the femoral component. It doesn’t have anterior part of the femoral component. Sixty two knees were investigated using this trail component. At first, extension gap was made by standard resection of distal femur and proximal tibia. Flexion gap was made 4 mm pre-cut of the posterior femoral condyles. Rotation of the pre-cut line was decided by anatomical landmarks initially. All osteophytes were removed and soft tissue release was performed if necessary.

After checking bone gaps, the pre-cut trial component was attached to the femur and the component gap was estimated. After the pre-cut trial component setting, the gaps were completely same as the component gaps after measured resection technique. According to the component gaps, femur was resected completely as the final step of the surgery. The amount of additional cut of posterior femoral condyles and the rotational position of the femoral component were decided freely for adequate gaps and ligament balance.

Results:

After management of osteophyte and soft tissue, bone gaps were 18.2±2.1 mm in extension and 16.6±2.8 mm in flexion. After setting the pre-cut trial component, component gaps were 8.6±2.1 mm in extension and 12.4±2.9 mm in flexion. Extension gap became 1.6±1.1 mm smaller than expected and the change of flexion gap was 0.3±0.6 mm by setting the pre-cut trial component. The average decrease in extension gap was not so big but the variation was not small (0~4 mm).

Conclusion:

Although, the difference between bone gap and component gap is very important for adequate extension and flexion gaps in TKA, component gap is impossible to know before final bone resection with usual technique. If there are unacceptable results after estimating component gaps, it is difficult to correct them. With the presented technique, component gap can be checked before final bone resection and true precise gap control will be possible.

Poster: 121
#587

Universal Surgical Devices Among Different Manufacturers and Implants in Total Knee Arthroplasty

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Introduction:

No little manufacturers makes so many kind of implants for total knee arthroplasty (TKA). Although, the only aim of surgical procedure of TKA is to make good ligament balance and adequate gap space in extension and flexion position of the knee, there are so many kinds of surgical devices which belong to each implant. The purpose of this study is to develop a universal surgical device as a basic surgical tool which is available among different manufacturers and implants with both measured resection technique and gap technique in TKA.

Materials and methods:

A new universal surgical device which is composed of a spacer block system and an aiming device for a femoral 4-in-1 cutting guide was developed. The spacer block system is changeable in thickness and medial-lateral angle and the aiming device can set the 4-in-1 cutting guide freely in AP and rotational position. Ninety five knees were implanted with this device. At first, extension gap was made by standard resection of distal femur and proximal tibia. Flexion gap was made smaller than usual measured resection by 4 mm pre-cut of the posterior femoral condyle. Rotation of the pre-cut line was decided by anatomical landmarks initially. Removal of osteophytes and soft tissue release was performed if necessary. It was easy to remove even large posterior osteophytes through the small flexion gap space which was made by the pre-cut. Extension and flexion gaps and ligament balance were checked by the spacer device. As the final step of the surgery, the amount of additional cut of the posterior femoral condyle and the rotational position of the femoral component were decided freely with the 4-in-1 cutting guide aiming device for a proper gap and balance. Two different components (different companies) were implanted with completely same procedure by only exchange of the 4-in-1 cutting guide aiming devices for each component.

Results:

After pre-cutting of femoral posterior condyle, extension gap was 16.7±2.9 mm and flexion gap was 14.9±2.3 mm. Flexion gap wasn't so small against the amount of pre-cut (4 mm). To avoid much bigger flexion gap,

cruciate retaining (CR) components were selected in 61 knees and posterior substitute (PS) components in only 33 knees. Eighteen knees could not achieve good ligament balancing in flexion and the rotation of the femoral component was changed as gap technique. The other knees were good in flexion balance and the femoral components were implanted as measured resection technique without any change of femoral rotational alignment.

Conclusion:

Although, there is no difference in the final purpose of the surgical procedure in TKA, surgeons have to obey the devices provided by each product company. Of course, it is necessary to be available some special devices with each implant, but it is better to have the universal system which is available with every implant in TKA especially for young surgeons. With presented device, both measured resection technique and gap technique and both CR and PS components are available with every implant.

Poster: 122
#1013

The Clinical and Radiological Analysis After Removal of Solidly Fixed Femoral Implants by Extended Trochanteric Osteotomy During Hip Revision

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Abstract Objectvie

Although the extended trochanteric osteotomy can provide improved exposure and more reliable healing, however, the strength and integrity of the femur may be substantially altered once this procedure has been performed. Therefore, this study was designed to analysis the clinical and radiological results after hip revision by extended trochanteric osteotomy to remove the solidly fixed femoral implants.

Methods

We retrospectively reviewed 33 revision total hip arthroplasties with the extended trochanteric osteotomy performed in 33 patients from January 1998 to June 2007. Indications for use of the trochanteric osteotomy were removal of solidly-fixed femoral implants. We analysised the complication rate such as trochanteric osteotomy nonunion, broken wires, the trochanteric migration, the stem subsidence, and the position change of the femoral stem. All measurements were done from the supine anteroposterior (AP) radiograph of the pelvic and a Lauenstein lateral radiograph. We compared the complications for this study using 6 weeks postoperative and%

Poster: 123
#773

Use of Monorail External Fixators in Failed Megaprosthesis at Knee.

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Abstract-

Failed megaprothesis is a disaster for any joint and the patient as awhole.

It not only causes some difficulty to the joint, to the patients and the hospital.

Wrong selection of implant, use of wrong custom made prosthesis, improper physiotherapy and osteoporosis are the most important reasons for the the failed megaprosthesis.

We present four cases of tumors of the lower end of femur of different origin, exicsed and treated with use of custom made megaprosthsis, started walking with support but failed in the spann of three to five months. Second surgery done in all and repeat megaprosthesis fixed in all.

After a period of eight months to one year they failed again and the stem of the prosthesis broken.

Treatment-

All were treated with the help of monorail external fixator, prosthesis removed with great difficulty and cement of the stem removed from both the ends from femur and the tibia.

Use of fibula as inlay graft were done in two, proximal coticotmy done at femur. Gradual compression distraction done and union is followed in a period of one year to one and half year.

Results-

All got united, weight bearing could be started gradually with the help of walker or calipers. Repeat radiography, care of only for the patient but to the surgeon too.

Pin site, few debridements use of drugs, antibiotics and calcium were the regular options.

Conclusion-

In the siutuation like failed megaprosthesis twice or more leads to a difficult situation not only for the patient but to the surgeon too.

With the use of ilizarov ring fixator or the monorail fixator not only helps the patient economically cheap option, but keeps him /her moblile and once the lenght obtained, it may help in any future planning for replacement too.

Poster: 124
#465

In Vivo Kinematics of Transepicondylar Axis for Fixed and Mobile Bearing Posterior Stabilized Knee Prosthesis With a Navigation System

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Introduction

Interest in the kinematics of reconstructed knees has increased since it was shown that the alteration of knee motion could lead to abnormal wear and damage to soft tissues. Since the in vivo kinematic study to compare mobile-bearing with fixed-bearing prostheses, analyses have been done to determine the kinematics of mobile- and fixed-bearing prostheses. We performed intraoperative kinematic measurements using a navigation system to study in vivo kinematics of transepicondylar axis for mobile and fixed-bearing posterior substituting rotating platform total knee arthroplasty (TKA) in the same knee.

Materials and Methods

Twenty patients (15 osteoarthritis and 5 rheumatoid arthritis, average age 72 years) undergoing posterior substituting rotating platform TKA (PFC sigma RP-F; DePuy Orthopaedics Inc., Warsaw, IN, USA) at our institute gave their informed consent to participate in this study. Intraoperative passive kinematics was measured twice with the trial component of mobile and fixed platform in place on the same patient with a computed tomography-guided navigation system (Vector Vision; Brain Lab, Heimstetten, Germany). From the acquired kinematics data, we defined the X-Y-Z coordinate system of the femur as mentioned below. Z-axis was the planned femoral mechanical axis. X-axis was parallel to the planned epicondyle axis and orthogonal on Z-axis. Y-axis was orthogonal on Z- and X-axis. The points of the all landmarks were expressed by the position information on the coordinate system of the involved bone using the coordinate transformation matrix. We investigated the coordinate points of medial epicondyle (MEP), lateral epicondyle (LEP), and the transepicondylar axis. We compared the maximum posterior distance of the MEP and LEP on the Y-coordinate, the rotational pattern, and the rotational angle on an X-Y plane of the transepicondylar axis between fixed- and mobile-bearing prosthesis in the same knee. Statistical comparison was performed using paired *t* test and all differences were considered significant at probability level of 95% ($P<0.05$).

Results

The maximum posterior distance of the MEP and LEP on the Y-coordinate had no significant difference between fixed knees (12.1 ± 4.5mm and 14.2 ± 4.8mm, respectively: mean ± standard error) and mobile knees (12.6 ± 4.0mm and 13.2 ± 4.4mm, respectively). In the mobile-bearing group, the rotational pattern of the transepicondylar axis was all external rotation to tibia. In the fixed-bearing group, it was external rotation to tibia except internal rotation of two cases. The rotational angle on an X-Y plane of the transepicondylar axis had no significant difference between fixed knees (3.5 ± 2.8º) and mobile knees (3.2 ± 2.2º).

Discussion

The expected kinematic pathway obtained from intraoperative transepicondylar axis kinematic was early rollback, medial pivot with external rotation, and bicondylar rollback. The results from the current study showed that these kinematics were not affected by the tibial insert. This result also suggested that the surface of the fixed insert was subjected to be a greater stress. Strength of the present study is that the comparison was performed in the same knee. This measurement can decrease confounding varieties.

Poster: 125
#498

Total Knee Arthroplasty Using Extramedullary Femoral Guide in Specific Bone Disease

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Introduction:

In total knee arthroplasty, many surgeons use intramedullary femoral guide and extramedullary tibial guide for bone cut. Intramedullary guide is more accurate than extramedullary guide, but causes destruction of bone marrow. Again, in specific case there may be difficulty at using intramedullary femoral guide. In this paper we report about the benefit of extramedullary femoral guide under fluoroscopical control.

Surgical technique:

After medial parapatellar arthrotomy tibial bone cut is performed using extramedullary guide, then femoral guide rod is inserted between quadriceps muscle and femoral shaft. Under fluoroscopy the varus/valgus alignment of the rod is adjusted precisely and distal femoral bone cut is performed to be perpendicular to the functional axis. After anterior, posterior and chamfer cut, each components of proper size are fixed.

Case 1: 70 years old female, originally diagnosed as multiple exostosis with familial involvement. She had left knee pain for 10 years and her valgus knee deformity increased gradually. Preoperatively the femorotibial angle was 150 degree and the metaphysis of femur was significantly enlarged, apparently difficult to set guide rod in proper position. Femoral bone cut was performed by extramedullary guide technique and the arthoplasty was finished successfully. Postoperatively the femorotibial angle improved to 174 degree and all the components were placed in proper position.

Case 2: 65 years old male, originally diagnosed as osteopetrosis since younger age but received no treatment to the disease. He had right knee pain since 4 years ago and had arthroscopical debridement, which produced only limited effect. Preoperatively the femorotibial angle was 179 degree and whole the skeletal bones were sclerotized, impossible to insert guide rod into the femoral bone. Similarly femoral bone cut was performed by extramedullary guide technique with uncommonly longer time and supplementary batteries, sawblades due to the extraordinary hard bone. At tibial bone cut there occurred a small crack on medial tibial condyle, all the procedure was completed finally. Postoperatively the femorotibial angle became 174 degree and all the components were fixed in proper position

Discussion:

Total knee arthroplasty was performed successfully even for specific bone condition. Extramedullary guide technique navigated by fluoroscope is a unique and effective method for femoral bone cut.

Poster: 126
#490

Clinical Application of Three-Dimensional Models in Patients With Severe Destructed Hip

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Full-scale three-dimensional (3D) models offer a useful tool in preoperative planning, allowing full-scale stereoscopic recognition from any direction and distance with tactile feedback.
The present study assessed the utility of full-scale 3D models in severe destructed hip surgery.
Preoperative two-dimensional images resulting from plain film radiography, computed tomography (CT) and magnetic resonance imaging provide limited morphometric information.Full-scale three-dimensional (3D) models are accepted as a useful tool for preoperative planning.
Chemical and natural wood 3D models of 4 full-sized hip(pelvis) were fabricated using rapid prototyping techniques from 1-mm slices of individual CT data. 3D models were created compact milling machine.
A comfortable alignment for patients was reproduced from CT data obtained . Usefulness of these models was analyzed. Using models as a template, appropriate shape of the plate construct could be created in advance. No patients complained of dysphasia following surgery. Adjusting plates and Screw entry points were simultaneously determined with full-scale dimensions and perspective, proving particularly valuable in cases involving high-riding vertebral artery. Full-scale stereoscopic recognition has never been achieved with any existing imaging modalities. Full-scale 3D models thus appear useful and applicable to all complicated hip surgeries. The combination of computer-assisted navigation systems and full-scale 3D models appears likely to provide much better surgical results.

Poster: 127
#611

The Diagnosis and Prophylaxis of Venous Thromboembolic Disease in Our Hospital

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Purpose

Venous thrombo-embolism(VTE) is a serious complication under total hip arthroplasty(THA). Therefore it is necessary to notice and prevent VTE. We examined the frequency of incidence of VTE by multidetector-row computed tomography (MDCT) and blood maker for 330 patients in our hospital. At now, we performed the intermittent massage of lower extremities during operation, the rate of venous thromboembolic disease was examined.

Patients and methods

The 330 patients(48men and 282 women) who performed primary THA from August 2007 to May 2011 were examined in this study. According to the time of operation, three groups in each of 110 patients were divided. The Average age at the operation was 65 years (rage, 34-88 yaers). MDCT examination was peformed the day after

operations in order to diagnosis VTE. 58 (17.6%)patients were positive of VTE and the rest of them were negative group. We examined the age, body mass index(BMI), blood loss, operative time, blood soluble fibrin monomer complex(SFMC) in the positive-negative group of VTE. The distance from the tibial joint line to the level of DVT was measured.

Results

Average age of positive group was 68 years and negative group was 65 years. Positive group was older than negative group. BMI, blood loss, operative time was no significant differences. The average SFMC (positive group of DVT) were 22.4±26.4μg/ml, versus 12.7±14.9μg/ml for the negative group. The SFMC was significant. The mean of distance from the tibial joint line to the level of DVT was distally 127.2mm.

Discussion and conclusion

The amount of SFMC was significant more than VTE positive group, SFMC examination was useful to evaluate DVT and pulmonary embolic disease. According to surgery term from 2007, the rate of venous thromboembolic disease for last 110 patients in our hospital was reduced by shortly operative time and intermittent massage of lower leg intra and after operation. Recently chemoprophylaxis therapy was recommended under THA operation, but rapidly performed operative techniques and massage at the time of surgery were useful methods to prevent the VTE. In the future, we produced the sterile massage machines to reduce the serious complication of VTE.

Poster: 128
#555

The Results of a CT Based Custom-Made Cementless Stem After Intertrochanteric Femoral Osteotomy in Total Hip Arthroplasty

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Introduction:

To obtain strong early fixation and proximal fixation, we used CT based custom-made stems for femora after intertrochanteric femoral osteotomy in Total Hip Arthroplasty.

Methods:

Thirty-eight hips of 34 patients were reviewed. The average age at surgery was 63 years (range, 29 to 77 years), and the average follow-up period was7.5 years (range, 2 to 15 years). The underlying etiology was secondary osteoarthrosis in36, CDH in 1 and post traumatic osteoarthrosis in one. Intertrochanteric varus osteotomy was performed in 19 hips and intertrochanteric valgus osteotomy in 19 about 30 or 40 years ago. The Ti-6Al-4V stems designed with CT data were inserted using individual rasp and CT based navigation system. Harris hip score was used for evaluation of clinical symptoms.

Results:

The average preoperative Harris hip score was 50 points (range, 19 to 74 points). At the most recent follow-up, the score was 82 points (range, 51 to 97). Thirty-seven stems were evaluated as bone-ingrown fixation and one stem as stable fibrous fixation by Engh's criteria. Five femora were evaluated as Grade 2 or 3 stress sealding by Engh's criteria. Stress sealding was observed in femora with low cortical ratio.

Conclusions:

In conclusion, the results of a custom-made cementless stem after intertrochanteric femoral osteotomy was excellent, but stress sealding is still problem.

Poster: 129
#424

Distal Femoral Rotational Alignment Based on a Mechanical Axis of the Femur: A 3D CT Scan in Vivo Assessment

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Background:

Measurements of rotation axes of distal femoral region using computed tomography imaging are affected by the position of the lower extremity, the degree of bending of the femoral region, and the skillfulness of the image taker, reproduction of these results might involve errors. In the present study, these authors attempted to examine and analyze the relationships between the rotation axes of the distal femoral region using 3-dimensional computed tomographic images taken perpendicularly to mechanical axes.

Methods:

Fifty 3D CT images perpendicular to the mechanical axis were obtained. The mechanical axis were determined by determining the points where the centers of the 3-dimensional computed tomographic image on the axial and coronal plane where the diameter of the head of the femur was the largest and the point where the intercondylar center of the femur in the image immediately before the image where the intercondylar notch disappears among images on the axial plane and the axis that passes through the center of the intercondylar notch on the coronal plane meet together as the center of the distal femoral region (Fig. 1A-B, 2). In the tomographic images taken perpendicularly to the mechanical axis, we measured the anatomical transepicondylar axis, the surgical transepicondylar axis, the Whiteside's line, and the real posterior condylar axis (rPCA)(Fig. 3). Unlike the selection of the femoral posterior condylar axis from one existing tomographic image, the real femoral posterior condylar axis was measured by connecting the rearmost points of the medial posterior condyle and the lateral posterior condyle after moving the rearmost point of the lateral posterior condyle to the image where that of the medial posterior condyle was taken, and overlapping the images in cases where the rearmost points of the medial posterior condyle and the lateral posterior condyle and were not on the same image (Fig. 4). As a method to have the center of the femur head and the distal femoral intercondylar center meet together in the recombinant 3D femur model, the images were aligned along a mechanical axis on a table.(Fig.5)

Results:

The angles to rPCA formed by A-TEA, A-TEA, and Whiteside's line were 6.34°±1.23°, 2.43°±1.56°, and 96.52° ±1.77°, respectively. The angles to A-TEA formed by Whiteside's line and S-TEA were 90.19±1.61°and 3.91±0.90°, respectively. In the recombinant 3D model, the angles to rPCA formed by A-TEA and Whiteside's line were 6.29°±1.86°, and 93.33°±3.76°, respectively. And the angle for Whiteside's line from A-TEA was 87.04°±4.11°. In the measuring methods using either tomographic images or 3D recombinant bone models perpendicular to the mechanical axis, results that were reproducible within and between observers were shown.

Conclusions:

The method to measure the rotation axes of the distal femoral region using tomograms taken perpendicularly to the mechanical angle is considered reproducible. In particular, the measurement method using the anatomical transepicondylar axis is more accurate than that using the Whiteside's line.

Figures

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Figure 5

Poster: 130
#511

180 Degree Rotatory Dislocation of Rotatory Platform After Posterior Dislocation of a Posterior-Stabilized Total Knee Arthroplasty: A Case Report

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Although instability remains one of the main reasons for early revision of total knee arthroplasty, complete dislocation of the posterior-stabilized total knee arthroplasty is very rare but dreaded complication. The authors report an unusual case of acute 180 degree rotatory dislocation of rotatory platform after posterior dislocation of a posterior-stabilized total knee arthroplasty.

Poster: 131
#477

Stemless Revision TKA Utilizing Press-Fit Metaphyseal Sleeves: Early Results of a New Technique

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Introduction:

Revision TKA can be a difficult and complex procedure. Bone quality is commonly compromised and stem fixation is required in many cases to provide stability of the prosthetic construct. However, utilization of diaphyseal engaging stems adds complexity to the case and can present technical challenges to the surgeon. Press fit metaphyseal sleeves can provide stable fixation of the construct without the need for stems and allows for biologic ingrowth of the prosthesis. Metaphyseal sleeves simplify the revision procedure by avoiding the need to prepare the diaphysis for stems, alleviating the need for offset stems, shortening operative time and decreasing the risk of intra-operative complications. This study reports on the authors early experience with this novel technique.

Materials and Methods:

Between May 2007 and June 2009 the author performed 18 revision TKA's that utilized press-fit metaphyseal sleeves without stems on either the tibial side of the joint, the femoral side of the joint or both. Twenty six sleeves were implanted altogether. Patients were limited to touch down weight bearing for 6 weeks post-operatively. The patients were followed prospectively with clinical and radiographic follow-up at routine intervals. Knee Society scores were obtained at the follow-up intervals as were routine weight bearing radiographs. Minimum 2 year F/U was required to be included in the analysis.

Results:

All 18 patients met the minimum 2 year clinical F/U requirements. Average F/U was 30.3 months (range 24 – 46). Fifteen of these patients had minimum 2 year radiographic follow up as well. Average age of the patients was 58 years (range 46-72). There were 7 females and 11 males. Average BMI was 32.4. Ten knees were revised for aseptic loosening and /or osteolysis, two were revised for septic loosening and two were revised for instability. Pain / stiffness and other causes accounted for the other 4 knees. Operative times averaged 151 minutes. Pre-op and post-op ROM averaged 2-108 deg and 1-118 deg respectively. Pre and post-op KSS were 35 and 88 respectively. Average pre and post-op functional scores were 51 and 76 respectively while average pre and post-op pain scores averaged 11 and 47 respectively. Radiographic analysis revealed all sleeves to be ingrown except for one tibial sleeve and one femoral sleeve that were possibly ingrown and one tibial sleeve that was revised at 30 months secondary to septic loosening. The possibly ingrown tibial sleeve subsided 1-2 mm laterally. No other subsidence was noted.

Conclusions:

Press-fit metaphyseal sleeves utilized without stems appear to provide excellent stability of the revision TKA construct at this early F/U. Biologic fixation appears to be present in the majority of cases. The sleeves proved easy to use and there were no intra-operative complications. This technique may provide a simple, but robust alternative when compared to revision TKA with stems in appropriate cases. Further F/U of this cohort is necessary to evaluate long term results.

Poster: 132
#844

Screening for Metal Sensitivity in Patients Undergoing Total Knee arthroplasty(TKA): A Prospective Study of Pre- and Post- Operation

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Purpose:

According to previous reports, metal sensitivity(MS) develops in 20-25% of patients who have undergone total knee
arthroplasty(TKA). However, only a few highly susceptible(<1%) patients exhibit symptoms such as eczema or erythema and there currently is little information concerning adverse effects caused by MS.
The purpose of this study was to investigate clinical importance of preoperative screening for MS and prevalence of symptoms
caused by metal hypersensitivity after TKAs.

Methods:

A series of 48 subjects(61knees) who underwent primary TKAs were enrolled in the study(6 male, 42 female, mean age 75 years).
All of subjects have no previous history of metal hypersensitivity. Preoperatively, detail of a personal history was collected and
MS was accessed by patch testing using the following haptens: cobalt (Co), nickel(Ni), chromium(Cr), aluminium(Al), vanadium(Va),
titanium(Ti), and molybdenum(Mo).In addition, blood samples were taken from each patient for lymphocyte stimulation test(LST).
The subjects were randomized received either a Co-Cr-Mo or an ceramic surfaced oxidized zirconium(Zr) implants after appropriate
informed consent had been obtained.Postoperatively, presence of eczematous dermatitis around operative scar and joint effusions
were evaluated. Radiographic accessment was made on the results of shift or subsidence of implant position and radiolucency
of the cement-bone or bone-prosthesis interface.

Results:

Preoperatively, 3 of the 48 subjects showed positive LST to Co and one of those exhibited positive patch testing, who was
excluded the study and received ceramic TKA. 13 of all subjects displayed positive LST to Ni and 2 of those exhibited
positive patch testing to Ni, who received Ceramic surfaced Zr implants. The results of LST and patch test to Cr were negative
for all the subjects. No one exhibited positive results of patch test to Al, Ti, Va, and Mo.Postoperatively,
the mean follow-up reached 15.6 months at the time of the last examination. 29 of 61 knees were received Co implants
and one patient developed a superficial infection. No localized or generalized eczema was confirmed in the rest of the patients.
32 knees were received Zr implants and no eczema was identified either. There was no difference as related to recurrency of

joint effusion and evidence of radiolucency between the 2 groups of the different implant materials.

Discussion:
Although metal hypersensitivity after TKA might be a rare complication, exclusion of MS before surgery seems to be critical to
prevent implant failure. Our results suggest that Ni is the most common metal allergen in the general population with
no history of metal allergy. There were no adverse effects attributable to implant material in the short period and further study is necessary to evaluate potent benefit of the Zr implant.

Poster: 133
#1117

Fluoroscopic Analysis of Medial-Pivot Total Knee Arthroplasty(TKA)

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The Objective of the study is to examine knee kinematics for 7 subjects with severe valgus deformities and compare pre- and post-operative kinematics for the same subject implanted with The ADVANCE Medial Pivot(MP) Knee System(Wright Medical Technology, Arlington, TN). In vivo Three-dimensional kinematics were determined by fluoroscopic examinations of subjects using a single-plane model-image registration technique. From weight bearing knee extension to maximum flexion, preoperative knee kinematics demonstrated external tibial rotation and small posterior femoral translation associated with paradoxical anterior slides during partial range of motion. These motions differed significantly from patterns previously reported for normal knees and arthritic knees. Postoperatively, paradoxical external rotations of tibias were restored and most subjects exhibited small internal rotations of tibias and reduced posterior translations of femurs. The flexion performance was maintained postoperatively. The present study suggests that the non physiological knee kinematics established in the severe valgus deformity is able to be altered more stabilized following arthroplasty even in absence of posterior cruciate ligament or cam-post mechanism.

Poster: 134
#613

Experience With an Accelerated Rehabilitation Protocol Following Minimally Invasive Total Hip Arthroplasty

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Introduction.

Tissue-preserving, minimally invasive techniques combined with implants that provide reliable immediate stability creates the opportunity for accelerated recovery after surgery. The current study assess the impact of combining tissue preserving techniques and uncemented implants with immediate mobilization on the day of surgery on length of stay, complications, and readmission.

Methods.

231 consecutive primary hips were replaced from March to April, 2011. 218 of these 231 hips met the inclusion criteria of treatment using the superior capsulotomy surgical technique and patient age less than 80 years. Mean age of the patients was 57.3 years (range 23.5 to 79.9 years). 97 of the hip replacements were in men and 121 were in women. Porous coated acetabular cups were used and fluted, proximally plasma-sprayed femoral components were used (Lineage, Renaissance, Perfect RS; Wright Medical Technology). All acetabular components were implanted using a patient-specific mechanical navigation device (HipSextant, Surgical Planning Associates). The protocol included preoperative acetaminophen, celecoxib, and oxycontin when possible, general anesthesia, pre-emptive autologous blood transfusion when available, local bupivicaine, mobilization 2 hours after surgery. Discharge criteria were unchanged. Patients were allowed unrestricted motion and weight bearing after

surgery. Length of stay, disposition, readmission, and complications were assessed.

Results.

Mean length of stay was 1.6 days. Length of stay was 0 days for one patient (<1%), 1 day for 115 patients (50%), 2 days for 71 patients (31%), and more than 2 days in the remaining 31 patients (13%). 215 patients were discharged home (99%). Of the 3 patients transferred to rehabilitation, one had cerebral palsy and the other had end stage renal disease, a mechanical heart valve, and a longstanding complete sciatic palsy on the contralateral side. One patient, discharged on post op day 3, was readmitted 3 weeks postop for an antiinflamatory induced GI bleed. Another patient, discharged 4 days after surgery, was readmitted 8 months later for I&D for acutely increasing pain but with no evidence of infection. Otherwise, there were no readmissions, reoperations, dislocations, nerve injuries, or post-discharge blood transfusions.

Conclusion.

The current peri-operative immediate mobilization protocol, combined with tissue-preserving, minimally invasive surgical techniques and implants designed to achieve immediate fixation, resulted in dramatic reduction in length of stay. Complications did not occur in any of the patients that were discharged within 48 hours of surgery. Current studies are underway to assess if pre-emptive autologous blood transfusion is a statistically significant independent variable associated with outcome.

Poster: 135
#615

Femoral Neck Anteversion: Implications for Acetabular Component Positioning and Femoral Component Design

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Introduction.

Femoral anteversion is typically measured from the base of the neck to the center of the femoral head (1). However, while this angle is relevant to native femoral anatomy and to hip resurfacing, it has no direct relevance to total hip arthroplasty since the femoral head is removed during surgery. When reconstructing the hip during total hip arthroplasty, anteversion of the femoral neck is critically relevant due to its strong influence on the version that an uncemented femoral component would likely assume. Thus, anteversion of the femoral neck has paramount relevance to total hip arthroplasty. A better understanding of the variation in femoral neck anteversion can improve our understanding of our goals to correct femoral anteversion surgically, our goals of acetabular component anteversion, and potential improvements in design of femoral components for total hip arthroplasty. The current study assesses the variation in anteversion of the femoral neck in patients undergoing total hip arthroplasty.

Methods.

The femoral neck anteversion in 270 hips treated by total hip arthroplasty was assessed. Each patient underwent a preoperative CT study for three-dimensional planning of CT-based surgical navigation of the hip arthroplasty (VectorVision, BrainLAB, Germany). Femoral neck anteversion as measured through the center of the femoral neck as opposed to the center of the femoral head was determined.

Results.

Of the 270, 136 hip arthroplasties were performed in women. The mean femoral neck anteversion was 29.4° +/- 10.8° (range, 8° to 61°). 134 hip arthroplasties were performed in men. The mean femoral neck anteversion was 23.7° +/- 8.4° (range, 4° to 46°).

Discussion.

Femoral anteversion historically has not been studied in a large volume of hips in the exact relevant patient population. The advent of CT-based surgical navigation has allowed for the acquisition of information that has previously not been available. Anteversion of the femoral neck in the current study group appears to have a higher mean for both men and women than traditional measurements of femoral anteversion as measured to the center of the femoral head. These results suggest a very wide variation in rotation of the femur which, during arthroplasty, needs to be corrected toward normal either through changing the implant rotation within the bone or through implant design above the femoral neck. Since, with uncemented femoral components, rotational correction within the bone itself is limited, appropriate correction on the femoral side requires either nonmodular designs with increased options for prosthetic femoral neck anteversion correction or modular components with an ability to correct abnormal rotation above the osteotomy.

It is likely that improved knowledge of individual patient pelvic tilt and femoral neck anteversion will allow for further refinement in implant design for correction of femoral anteversion and further refinement of goals for acetabular component orientation.

1. Murphy SB, Kijewski PK, Simon SR, Wilkinson RH, Griscom NT. Femoral anteversion. Journal of Bone and Joint Surgery. 1987; 69A(8):1169-1186.

Poster: 136
#618

Improving Cup Positioning Using a Mechanical Navigation Instrument

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Introduction.

Acetabular component malpositioning is the most common reason for instability and wear resulting in revision total hip arthroplasty (THA). Studies repeatedly demonstrate that more than half of conventionally placed cups are malpositioned (1). Yet, while traditional navigation techniques, whether image-free or image-based, have been shown to reduce acetabular component outliers, routine using of navigation in surgery has not been widely adopted. There may be a need for simpler and faster methods of accomplishing the same task. A novel mechanical navigation device, the HipSextant, was developed which is designed to predictably dock on the ipsilateral hemipelvis during surgery (2). Based on CT modeling and individual patient planning preoperatively, the docking of the instrument registers the pelvis in space. An adjustable direction indicator points in the surgeon-defined desired cup orientation. The current study aimed to assess the accuracy of this mechanical navigation device as compared to a series of hip arthroplasties performed using CT-based computer-assisted cup placement.

Methods.

The study group consisted of 70 THAs performed using the mechanical device. The control group consisted of 146 THAs performed using CT-based computer navigation. Postoperative cup positioning was measured using a validated 2D/3D-matching method. An outlier was defined outside a range of ± 10 degrees from the planned inclination or anteversion.

Results

In the study group, the mean error for inclination using the mechanical navigation device was 1.3° +/- 3.4° (range, □6.6° to 8.2°) and 1.0° +/- 4.1° (range, □8.8° to 9.5°) for anteversion. The mean error for inclination for the

control group was greater (p less than 0.001) than that for the mechanical navigation group (3.5° +/- 4.2°; range, □12.7° to 6.9°) and greater (p = 0.003) for anteversion (3.0° +/- 5.8°; range, □11.8° to 19.6°). There were no outliers for either inclination or anteversion in the study group. The percentage of outliers in the control group was 9.6% (13 of 146), which differed significantly (p = 3.4%) compared with the study group. The mean length of operation was lower (p less than 0.001) in the mechanical navigation than the control group: 112 plus/minus 22 minutes (range, 78–184 minutes) versus 132 plus/minus 18 minutes (range, 90–197 minutes), respectively.

Discussion.

Although surgical navigation reduces the rate of malpositioned acetabular cups its use has not been widely adopted, possibly as a result of increases in cost, operating time, complexity, and capital equipment. As a result of our perceived need for simple and efficient methods of navigation, we developed a mechanical navi- gation device for acetabular cup orientation. The aims of this study were to (1) assess the accuracy of cup orientation

(mean error of cup inclination and anteversion) of this novel mechanical navigation device; (2) evaluate the percentage of outliers outside ± 10° of inclination or anteversion; (3) measure the length of operation using this device for navigated cup impaction during THA; and (4) compare the results of the mechanical navigation device with the accuracy, percentage of outliers, and length of operation of a series of CT-based computer-assisted THAs. The current study demonstrates that the use of this mechanical navigation device can result in reliable accuracy of acetabular cup orientation compared with CT-based surgical navigation. All cups were placed within a zone of ± 10 degrees range of inclination and anteversion. This mechanical navigation device allows accurate cup navigation with a minimum of equipment and additional operative time.

1. Callanan MC, Jarrett B, Bragdon CR, Zurakowski D, Rubash HE, Freiberg AA, Rubash HE, Malchau H. Risk factors for cup malpositioning. Quality improvement through a joint registry at a tertiary hospital. Clin Orthop Relat Res (2011) 469:319-329.

2. Steppacher SD, Kowal JH, Murphy SB. Improving Cup Positioning Using a Mechanical Navigation Instrument. Clin Orthop Relat Res. (2011) 469:423-428.

Poster: 137
#702

Range of Motion Comparison of Dual Mobility and Conventional Total Hip Arthroplasty to Hip Resurfacing Using Computerized Surgery

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INTRODUCTION

Since the 1970s, dual mobility bearings have been utilized in total hip arthroplasty (THA) to achieve increased range of motion and as an alternative to constrained liners. The purpose of this study was to determine the theoretical range of motion (ROM) before bony or prosthetic impingement of a dual mobility acetabular cup using computer-aided design modeling. The range of motion was then compared to that of conventional THA and hip resurfacing.

METHODS

CT scans of five cadaver hips were segmented using Mimics 13.1. Each three-dimensional cadaver model underwent virtual THA with a 28mm and 36mm head, hip resurfacing, and implantation with a dual mobility acetabular component. The sizing of components was based on individual cadaver anatomy. ROM to

impingement was tested in flexion, extension, abduction, adduction, internal/external rotation, internal/external rotation at 90° of flexion, external rotation with 20° of extension, and internal rotation with 45° of flexion. A one-way ANOVA was performed to look for differences in ROM between the types of surgery.

RESULTS

Compared to the other groups, the hip resurfacing resulted in significantly restricted ROM in all directions except adduction. The dual mobility construct resulted in similar ROM as the conventional THA with both head sizes for most motions. Compared to the 28mm head THA, the dual mobility cup resulted in significantly greater ROM in internal rotation with the hips flexed at 90° (39.4° vs. 31.8°, p=0.10). When head size was increased to 36mm, only external rotation with 90° of flexion favored the dual mobility construct.

DISCUSSION

This 3-D computerized simulation of dual mobility THA demonstrated superior or equal ROM in all tests when compared to hip resurfacing or 28mm head THA, suggesting a potentially more stable implant system. The benefits of the dual mobility cup diminished when compared to conventional THA with a 36 mm head. This ROM simulator data should be used along with polyethylene wear rates, and eventually clinical data, to evaluate this novel implant concept.

Poster: 138
#617

Prediction of 3D Pelvic Morphology Based on 2D Images: Implications for Navigation of Acetabular Component Orientation

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Introduction:

The ability to predict the three-dimensional docking of a mechanical cup navigation instrument on an individual patient basis using only plain radiographs could be applied to address the common problem of cup malposition during arthroplasty. The current study assessed the ability to make three-dimensional predictions based on 2D plain radiographs as compared to actual three-dimensional measurements based on CT imaging.

Methods:

Three-dimensional models from CT studies of 402 hips (101 left female, 96 left male, 94 right female, 111 right male) and plain radiographic images were used to develop statistical models of the pelvis to predict the three-dimensional docking of a mechanical navigation instrument. These models were applied to 56 hips treated by total hip arthroplasty that were not used to create the original models. We then compared the predictions based on plain radiographs to the actual 3D CT models on the same patients. Errors were calculated in degrees of operative anteversion and inclination.

Results:

As compared to actual 3D models based on CT imaging, predictions using statistical models based on plain radiographs introduced errors in inclination of 1.95° ± 1.50° [range, 0.05° to 5.05°] and in operative anteversion of 2.2° ± 1.40° [range 0.08° to 5.45°].

Conclusion:

The current study demonstrates the potential to predict the patient-specific three-dimensional shape of the human pelvis based on plain radiographic images. Specifically, it is possible to predict the three-dimensional orientation of a mechanical instrument used for navigation of cup orientation.

Poster: 139
#619

Measuring Pelvic Tilt and Rotation Using 2D-3D Matching

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Introduction

Previously, we have introduced a program called "HipMatch" for accurate determination of cup orientation by performing a 2D-3D registration between a CT scan of the patient and a post-operative x-ray radiograph. The transformation that is obtained from the 2D-3D matching also allows one to transform the anterior pelvic plane from the CT data coordinate system to the x-ray image coordinate system for a computation of the pelvic tilt and rotation with respect to the x-ray imaging table/plate. In this paper, we present a cadaver study to validate the accuracy of measuring pelvic tilt and rotation using this previously introduced 2D-3D matching program.

Methods

Thirteen cadaver pelvises were used in our validation study. A custom-made holding device with radiolucent brackets was used to clamp each pelvis between the acetabula thereby allowing tilting around the interacetabular axis and rotation around the longitudinal axis in graded (1^{o}). Each pelvis initially was placed in a neural orientation. Starting from this neutral position, we then obtained serial digital Anterior-Posterior (AP) radiographs for different pelvic orientations. The pelvis was titled around two axes in graded increments of 3^{o} at a time. The maximum tilt amplitude was chosen to be $\pm 12^{0}$ and the maximum rotation amplitude was chosen to be $\pm 9^{0}$. At each position, we acquire one radiograph in a standardized manner. To validate the accuracy of measuring pelvic tilt and rotation using 2D-3D matching, we also obtained a CT scan for each pelvis. Each time one of the x-ray radiographs of a pelvis was used together with its associated CT data as the input to our 2D-3D matching program for a computation of the pelvic tilt and rotation. To measure the incremental tilt and rotation changes of the pelvis using the 2D-3D matching, we subtract the pelvic tilt and rotation measured using the x-ray radiograph acquired at the neutral position from those measured using the x-ray radiographs acquired at other positions. We then compared the incremental tilt and rotation changes as measured by the 2D-3D matching technique to the associated readouts from the custom-made holding devices, which we regarded as the ground truths.

Results

The differences between the incremental pelvic tilt and rotation changes as measured by the 2D-3D matching technique and the associated ground truths of all thirteen pelvises were obtained. An average difference of -0.2 ± 0.7^{0} (range: from -2.5^{0} to 1.6^{0}) was found for the pelvic tilt measurement and an average difference of -0.01 ± 0.7^{0} (range: from -2.1^{0} to 3.5^{0}) was found for the pelvic rotation measurement.

Discussion

In this paper, we present a cadaver study to validate the accuracy of measuring pelvic tilt and rotation using 2D-3D matching technique. Our experimental results demonstrate that the pelvic tilt and rotation can be accurately measured by performing a 2D-3D registration between a CT scan of the patient and an x-ray radiograph. One of our future directions is to apply this technique to more clinical applications such as investigating the pelvic tilt change before and after surgery.

Poster: 140
#1003

Deep Flexion Kinematics With Robotic Modular Knee Arthroplasty

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INTRODUCTION

In knee arthroplasty, several studies have shown that sparing soft tissue, particularly the ACL, will allow a patient to retain kinematic function that more closely relates to normal function versus those with cruciate substituting implants. While modular knee replacement has had good clinical results, difficulties exist in achieving precise implantation. Robotic-arm assisted orthopedic surgery has the potential to achieve levels of accuracy, precision, and safety not possible with conventional techniques. With the use of robotic-arm guidance Lonner examined a series of 12 consecutive modular bicompartmental arthroplasties using discreet components and observed a mean post-operative ROM at 126 degrees of flexion with statistically significant improvements in WOMAC and KSS scores at short-term follow-up. This study analyzed the kinematics of a series of patients that underwent robotic-arm guided knee arthroplasty with a modular implant system where both cruciate ligaments were preserved in a uni- or multi-compartment knee arthroplasty. No prior study has analyzed kinematics with modular knee arthroplasty.

METHODS

We analyzed six osteoarthritic knees that underwent robotic-arm guided knee arthroplasty with modular implant components. All surgeries were performed by one surgeon (SK). The age of the patients at time of surgery was 60 ± 10 years. The average patient follow-up was 12 ± 3 months. Patients were studied fluoroscopically while they performed daily living activities (lunge and kneel). 3D kinematics were assessed from single plane fluoroscopic images using a proven technique from Banks, et al.

RESULTS

The average maximum flexion angles observed during kneeling was 127 ± 7 degrees and 120 ± 10 during lunging. The mean axial rotation observed during kneeling was 27 ± 6 degrees and 28 ± 7 degrees during lunging. Mean rollback observed during kneeling was 19 ± 9mm and 17 ± 7mm during lunging.

CONCLUSION

The observed deep flexion kinematics related more closely to normal knee kinematics than previously published results for TKA. Although this study included a small number of patients, it was observed that robotic-arm assisted modular knee arthroplasty was indicated to replicate normal knee kinematics in deep flexion. Further research with a larger subset of patients would strengthen these findings.

Poster: 141
#1005

How Many Tka Patients Could Be Treated With Early Intervention Procedures?

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INTRODUCTION

The rationale behind bicompartmental arthroplasty is that many patients who undergo TKA have isolated bicompartmental arthritis involving only two compartments of the knee and have no significant deformity, excellent motion, and intact cruciate ligaments. This study evaluates the radiographic and early clinical results of bicompartmental arthroplasty with modular components implanted with robotic surgical arm guidance. We also include a retrospective review of total knee cases to examine the applicability of this early intervention procedure.

METHODS

Thirty consecutive modular bicompartmental knee arthroplasties were performed using robotic guidance. Clinical and functional data were collected pre-operatively and at 2, 6, 12 weeks and 1 year. The average BMI was 29; nineteen patients were women. We retrospectively reviewed intraoperative notes from 406 consecutive TKA

patients from a single surgeon which included the integrity of the three compartments and ACL.

RESULTS

At most recent follow-up, SF-12 PCS increased from 32.6 (preop) to 44.6 (p=0.05); WOMAC pain, function, and total score decreased from 11.0 to 2.8 (p=0.0001), 13.6 to 3.2 (p=0.0008), and 24.6 to 6.0 (p=0.0001) respectively; ROM increased from 122° to 138° (p=0.0001); KS function and knee score increased from 55.9 to 78 (p=0.03) and 40.1 to 92.4 (p=0.0001) respectively. There was no radiographic evidence of loosening, polyethylene wear or progressive lateral compartment arthritis. There were no complications in the peri-operative period.

In the review of 406 TKA cases, the ACL was intact in 66% of these cases. Based on these data alone, 16% of these TKA patients were indicated for a unicondylar arthroplasty and 31% were indicated for bicompartmental arthroplasty.

CONCLUSION

Modular bicompartmental arthroplasty is an effective method for treating arthritis of the knee restricted to the medial and patellofemoral compartments. Early results using contemporary prostheses are encouraging and should prompt further mid- and long-term study. Our data indicates that many TKA patients have healthy cruciates and disease in only two of the three compartments, indicating that TKA is an overtreatment of earlier stage osteoarthritis. Longer term studies will determine the clinical significance of preserving healthy cartilage and ligaments routinely resected with traditional tricompartmental TKA.

Poster: 142
#939

Initial Results of a Modified Flexion/Extension Gap Balancing Technique Using Soft Tissue Force Measurements in Total Knee Arthroplasty

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Introduction:

Early development of implants led to two surgical techniques for knee arthroplasty: the gap-balancing technique and the measured resection technique. The gap-balancing technique occasionally leads to elevation of the joint line, as the femoral component is moved anterior to avoid notching, which results in over-resection of the posterior condyles leading to a looser flexion space. To properly fill the flexion space with enough poly to gain flexion stability and to gain full extension of the leg, more distal femur may need to be resected, thus raising the joint line. Measured resection is dependent on compensatory soft tissue releases to accommodate the cuts performed by the instruments. However, regardless of technique, slight compounding inaccuracies of bone preparation make it sometimes difficult to achieve a well-balanced total knee. The purpose of this study was to compare a new flexion / extension gap (flex/ext) balancing technique using a force sensor plate and soft tissue distractor with a modified “balanced resection” technique (flexion only) where the force sensor was only utilized to establish a balanced flexion gap.

Methods:

For the new gap balancing technique, an initial distal femoral cut of approximately 5mm was performed followed by an anatomic tibial cut. The conventional eLIBRA instrumentation (Synvasive Technology) was then utilized to establish the femoral rotation to balance the flexion gap. After the anterior and posterior cuts were completed, posterior osteophytes were carefully removed and posterior capsular releases were performed as needed. The flexion gap was measured utilizing the eLIBRA force sensor and the extension gap was matched to the flexion gap using a soft tissue balancer with the leg in extension followed by re-cutting the distal femoral bone. The force sensor again was used during this step to get equal tension on the medial and lateral collateral ligaments. All cuts were measured utilizing computer navigation (Stryker Navigation). The results are compared to a control group of knees with measured resection and flexion gap balancing only. Mann-Whitney-U-test was performed to determine statistical significance ($p<.05$)

Results:

No differences were noted in pre and post-implantation femoral alignment and orientation of the femoral and tibial cuts between the techniques (data not shown). A 7° improvement (120.2 to 127.5) in mean flexion angle from pre to post implantation through the flex/ext gap balancing technique was significant (p=0.022) as compared to a 5° improvement (116.8 to 121.6) in mean flexion angle through the conventional technique (p=0.398). The final flexion value was also significantly higher (p=0.02) in the modified technique (Figure 1).

Discussion:

We provide preliminary results of an unpublished method to guide resection of the distal femur in standard TKA to obtain mechanically equivalent and dynamically balanced flexion and extension gaps. This soft tissue guided surgery using a force sensor plate does appear to achieve a well aligned extremity without requiring additional soft tissue release. Despite not using any bone landmarks to prepare the femur, both techniques did not impact overall alignment or femoral rotation. The significant improvement in intra-operative flexion will require more clinical trials to confirm its significance.

Figures

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Figure 2

Poster: 143

#902

Early Clinical Outcomes in Robotic Assisted Unilateral Bi-Unicompartmental Total Knee Replacement Compared to Conventional Knee Arthroplasty.

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Introduction:

Uni-compartmental knee replacement (UKR) allows use of smaller sized implants that require less bone resection and sparing of the anterior and posterior cruciate ligaments. This contributes to more normal kinematics that closely resembles the intact knee resulting in improved clinical outcomes especially when comparing to total knee replacement. However, it is rarely utilized in bicompartmental disease. Although technically very challenging, there are rare reports about bicompartemental (two UKR's) knee replacement with the preservation of the ACL and PCL utilizing conventional instruments or computer navigation. This is the first report of short-term clinical outcome of 9 bi-unicompartmental (one tricompartmental) knee replacement utilizing the Rios Robotic- assisted arm by MAKO. The Rios platform by MAKO is a surgeon interactive robotic arm with haptic guidance that allows computer assisted planning and intra-operative accurate placement of a bi-UKR assuring proper soft tissue balancing.

Methods:

A total of 9 knees in 9 patients were treated from 7/2009 to 3/2011 by one surgeon with bi-UKR, using MAKO robotic-assisted surgical technology due to a diagnosis of medial and lateral compartment osteoarthritis. All patients were evaluated post-operatively using self-administered Knee Injury Outcome and Osteoarthritis Outcome Score (KOOS) and Knee Society Score. For comparison, patients undergoing standard total knee arthroplasty and MAKO robotic-assisted UKR performed by the same surgeon within the same time period were reviewed. Figures 2-3 are pre and post-operative radiographs, respectively, of a patient undergoing the procedure.

Results:

Of the 9 patients undergoing the Bi-UKR, 9 returned to the clinic for follow-up. Post-operative data were collected at a mean follow-up time of 12.3 months (range, 2-20 months) for all subjects. Demographics are presented in

Table 1 with results of KOOS surveys in Figure 1.

	TKA	UKA	Bi-UKA	ANOVA
Sample (n)	30	19	9	
Age (years)69.962.464.8$F(2,54) = 3.228$, p=0.047				
STD	11.2	8.4	10	
Range	38-90	48-72	53-79	
BMI (kg/m^2)30.327.829.9$F(2,47) = 1.067$, p=0.352				
STD	4.9	5.5	5.5	
Range	23-37	22-43	23-41	
Time to follow-up (days)461.3542347$F(2,54) = 0.9$, p=0.412				
STD	340	542	208	
Range	141-1619	156-1126	58-609	

Table 1. Subject demographics presented as the mean for each group. STD=standard deviation. One-way ANOVA analysis performed for statistical significance.

Discussion:

Although media and lateral tibio-femoral arthritis is traditionally addressed through total knee replacement, our limited experience with the bi-UKR has shown promising outcomes with few post-operative complications. In addition, the surgery preserves the integrity of the both the ACL and PCL ligaments in contrast to total knee arthroplasty, which theoretically should approximate functional capabilities of the intact, functional knee. Given these advantages as well as preservation of intact bone and less soft tissue destruction as compared to total knee arthroplasty, further investigation with this surgery seems warranted as a viable alternative.

Figures

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Figure 4 HYPERLINK "http://app.istaonline.org/figures/1596.jpg" \t "_blank"
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Figure 6

Poster: 144
#442

Influence of Bone Mineral Density of Proximal Femur on Cementless Stem Subsidence in Bipolar Hemiarthroplasty for Femoral Neck Fracture in Elderly People

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Objective:

As a Japanese aged population has been increased most rapidly in the world, an awful lot of bipolar hemiarthroplasties (BHA) are undergone for the femoral neck fractures. Early post-operative rehabilitation

program is essential for the prevention of mortal complications as well as functional recovery. Although cementless stem is beneficial to avoid cardiovascular complication of bone cement and shorten surgical time, postoperative stem stability has been concerned in elderly people with poor bone quality. Nevertheless, the influence of severity of osteoporosis on the stability of stem has not been fully investigated with the assessment of bone mineral density (BMD).

The purpose of this study was to investigate the influence of BMD at proximal femur on the postoperative cementless stem subsidence in the elderly people.

Materials and Methods:

Forty four patients with age more than 65 years-old (35 females and 9 males, age; 77.5 ± 7.1 y.o.) who underwent BHA with cementless stem for femoral neck fractures were included. Inter-trochanteric BMD of proximal femur was measured at contralateral intact femur using dual energy X-ray absorptiometry at a week after surgery. Antero-posterior radiographies were taken at 0, 1, 3 and 12 months after surgery. The stem subsidence was measured at 1, 3 and 12 months. The influence of BMD on the stem subsidence was evaluated using a simple linear regression analysis. A p-value less than 0.01 was considered significant.

Results:

Mean BMD was 0.65 g/cm^2 corresponding to 60% of young adult mean value (YAM). Thirty three cases (75%) were diagnosed as osteoporosis with BMD less than 70% of YAM. Five patients (11.4%) showed stem subsidence more than 3mm after 3 months, and their BMD were all less than 50% of YAM.

Stem subsidence were 0.7±1.2 (mean ± SD), 1.6±1.3, and 1.7±1.2 mm at 1, 3, and 12 months respectively. Stem subsidence significantly increased during 3 months, and showed no significant increase after 3 months. BMDs had significant negative correlations to subsidence at both 3 and 12 months.

Discussions and Conclusions:

This is the first report that elucidates the influence of bone quality of proximal femur on the post-operative stem subsidence after cementless BHA for femoral neck fracture. We found the more stem subsidence would occur in the patient with the less BMD at proximal femur. Stem subsidence should be analyzed using BMD at proximal femur as a covariant to develop a new stem design for elderly people.

Poster: 145
#521

Intraoperative Radiographs and the Femoral Component in Primary Total Hip Arthroplasty

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[Objective]

Femoral component alignment, fit and offset influence leg length inequality, gait, poor muscle strength and other unsatisfactory long term results after Total Hip Arthroplasty (THA) also means a substantial amount of malpractice litigation. To acquire accurate femoral component size and position, we have used intraoperative radiographs taken with an acetabular component and a femoral trial. The purpose of this study is to evaluate whether intraoperative radiographs accurately determine the femoral component.

[Materials and Methods]

The study group included 100 primary THAs performed between September 2009 and April 2011. We investigated any intraoperative adjustments were made after reviewing the intraoperative radiograph by comparing them with the postoperative radiographs [Fig.1], and referred to the operative records. The final results were obtained by additional adjustments after reviewing the intraoperative radiograph. We assessed these results from the three standpoints: femoral component alignment, leg length, and femoral offset. In addition, the results were assessed and ranked with a three grade scale: satisfactory, unsatisfactory, no change. Femoral component

alignment was targeted for a neutral position; leg length and offset was targeted for preoperative planning.

[Results]

Some adjustments had been made in 78 cases. The adjustments included changes in the component size in 34 cases (43.6%), component alignment in 45 cases (57.7%), additional femoral neck cuts in 44 cases (56.4%), and changes of femoral offset in 17 cases (21.8%). The results of the component alignment adjustments were satisfactory in 55 cases (70.5%), unsatisfactory in 4 cases (5.1%), and no change in 46 cases (20.5%). The results of the leg length adjustments were satisfactory in 46 cases (59.0), unsatisfactory in 3 cases (3.8%), and underwent no change in 30 cases (38.5%). The results of femoral offset adjustments were satisfactory in 37 cases (47.4%), unsatisfactory in 6 cases (7.7%), and there was no change in 35 cases (44.9%).In 68 cases (87.2 %), accurate positioning was successfully achieved by taking intraoperative radiographs. In 10 cases (12.8%), preoperatively planned positioning was not accurate; there was 1 unsatisfactory item in 7 cases, 2 unsatisfactory items in 1case, 3 unsatisfactory items in 1 case, and 3 no change items in 1 case.

[Conclusions]

These data suggest that intraoperative radiograph is a useful method for placing femoral components according to a preoperative planning in THA. If we can gain both patients and surgeons satisfaction dramatically with just a little extra effort, no effort should be spared.

Figures

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Figure 2

Poster: 146
#552

Clinical Results of Profemur Z for the Femoral Neck Fractures in Patients Older Than 90 Years.

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We report the clinical and radiographic outcomes of more than 90-year-old patients with femoral neck fractures that were treated with Profemur Z. Between 2006 and 2010, we treated 142 patients with 152 fractures. There were 11 hip fractures in 10 patients older than 90 years. We conducted a survey for the 10 patients (10 females) with more than 3 months of postoperative follow-up. We retrospectively examined the records of clinical examination, and radiographic findings such as canal flare index (CFI), stem sinking, and stress shielding. We also examined how many corners of the rectangular stem cross-section were attached to the cortex of the medulla and what part of the cortex to which the corners were attached using postoperative CT imaging data. Of the 10 patients, 9 were able to walk and stand 2 weeks after the operation. The mean CFI was 3.27. Of the 11 hips, 4 were categorized as stovepipe-type, and 7 as normal-type. None of the patients had stem sinking. Stress shielding was noted in 4 hips. All four corners and three corners of the stem were attached to the cortex in 66.7% and 33.3% of the cases, respectively. These three or four corners were attached to the cortex at an average of 9 to 67 mm distal to the center of the lesser trochanter. The middle to distal part of the stem was found to be fixed. Two of the 22 patients underwent reoperation because of surgical site infection and dislocation. Profemur Z was useful in treating femoral head fractures in patients older than 90 years because it provided a good initial stability.

Poster: 147
#542

Uncemented Ceramic on Ceramic Bearing Couple for Dysplastic Hips

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In Japan, most diagnosis requires hip arthroplasty is dysplastic osteoarthritis. Patients are relatively young and have high activity. For such patients, expecting the better wear resistance and the longevity, we have been using the ceramic on ceramic bearing couple (CoC).

Material and Method:

Since November 1998, we have replaced 1615 dysplastic hips with uncemented CoC. Among them we evaluated 639 hips in 541 patients (12 males, 529 females) with five years or more follow-up. The average age at the surgery was 57. In Crowe's Classification 405 hips belonged to grade I, 166 to II, 46 to III, and 17 to IV (the rest five hips were after arthrodesis). The average of follow-up period was 7.0 (5.0 to 12.1) years. The metal shell was Spongiosa Metal II (GHE ®, Eska Orthodynamics GmbH, Lübeck, Germany) (SM) for all patients. The stem was SM for 422 hips and SL Plus ® Stems (Smith&Nephew AG, Rotkreuz, Switzerland) (SL) for 217 hips. SL stems were adopted for the narrow femoral canal. The bearing couple was 28 mm Biolox Forte ® (CeramTec AG, Plochingen, Germany). All surgeries were carried out through an anterolateral approach. Against the contracture, the adductor tenotomy was necessary for 180 hips and the extensive release of the tendons (including the quadriceps origin, the sartroius origin, and the gluteus maximus insertion) for 22 hips.

Result:

The Harris hip score was improved in all but five patients at the final follow-up. At the final follow-up, all cups but one (0.2%) and all stems were stable. In the acetabulum, the radiolucent line was observed in four hips (0.6%). In the femur, the line was observed around nine SM Stems (2.1%) and 65 SL Stems (30.0%). Osteolysis was detected in one femur (0.2%). Two hips (0.3%) required revision surgery due to the liner fracture because of the metal shell damage during the initial surgery. The average of cup inclination angle was 39.7 (23 to 59) degrees and that of cup anteversion angle was 27.3 (3 to 56) degrees. At the final follow-up, the average motion range was 90.1 (35 to 120) degrees in flexion, 6.0 (-10 to 30) in extension, 23.0 (0 to 50) in abduction, 10.2 (0 to 25) in adduction, 26.2 (5 to 45) in external rotation, and 25.5 (0 to 50) in internal rotation. In these alignments and motion range, we had no dislocation. Posterior edge loading occurred in one hip with insufficient cup anteversion. Using revision or requiring revision as end point, the survival rate was 100% at five years after the surgery and was 98.3% (95% confidence intervals, 96.0 to 100%) at ten years after the surgery.

Conclusion:

The revision rate due to the bearing couple associated failure of CoC (3/1615, 0.2%) was lower than that of low carbon metal on metal one (21/390, 5.4%) ($P<0.000$). Even for the dysplastic osteoarthritis, SM Cup provided a rigid initial fixation in the safe alignment and was suitable for CoC. The clinical and radiological results of uncemented CoC were satisfactory for dysplastic patients.

Poster: 148
#854

The Labral Lesions of Dysplastic Hip and Usefulness of Concomitant Management for Labral Lesions During Periacetabular Rotational Osteotomy

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Background

We performed concomitant hip arthroscopy during periacetabular rotational osteotomy (PARO) in intension to verify the features of accompanied labral lesions and clarify the correlation of labral lesions with early hip pain. We also expected to determine whether a concomitant management for the injured labrum during PARO can result in more favorable clinical results.

Methods

We investigated 52 hips in 49 patients with symptomatic hip dysplasia without advanced degenerative osteoarthritis. Arthroscopic examination has been performed during PARO. Labral lesions were described as the Lage's description. Three kinds of procedures were performed for the labral lesions, observation (group A, 29 hips), debridement (B, 10 hips), and repair (C, 7 hips). Clinically, Harris hip score, and impingement sign were evaluated. Radiologically, center-edge angle in anteroposterior and false profile view, and change of Tönnis osteoarthritis grade were evaluated. We followed up these patients for a mean period of 4.5 years. The statistical evaluation to define the factors associated with degree of pain, osteoarthritis change, and prognosis following the management for labral lesions.

Results

Labral lesions were found in 46 hips(88.6 %), and most of them were at anterosuperior(43.5%). Chondral lesions were found in 28 hips(53.8 %). The type of labral lesions were labral fibrillations in 10 hips, simple tears in 16 hips, and degenerative tears in 20 hips. A degree of pain has statistic correlation to the presence of degenerative labral tear($p=0.022$), not chondral lesions($p=0.407$). Simple tears, especially peripheral longitudinal tears were frequently observed in patients with Tönnis grade 0(12/14 hips), and degenerative tears in patients with Gr I(17/31 hips). There were no clinical difference at last follow up among the group A, B and C. Impingement signs were also improved in all groups. Relief of groin pain and disappearance of impingement sign after PARO showed no statistical correlation with any factors such as age, sex, degree of postoperative CEA, and even whether the labral lesions were treated or not. Osteoarthritis according to the Tönnis grades were improved in 12 hips, progressed in 2 hips and not changed in 38 hips. Two cases with deterioration in degenerative osteoarthritis were found in the group with labral debridement(group B). One of them showed inadequate surgical correction of acetabular coverage and both of them were involved by focal advanced cartilage degeneration(Noguchi grade 3). The improvement of osteoarthritis was only statistically correlated with preoperative status of osteoarthritis($p=0.005$).

Conclusion

The labral lesions in most of symptomatic hip dysplasia are caused by abnormal stress concentration to acetabulum rather than impingement and they seem to be the main cause of initial or early hip pain in symptomatic patients without advanced osteoarthritis. If the abnormal concentration of joint stress is ameliorated by PARO and followed by adequate joint stress redistribution and joint stability, we can expect to improve the hip pain even when the labral lesions retained without any management. The existence of labral lesions seems to affect the initiation of hip pain but does not seem to affect the clinical course of hip joint after PARO up to midterm follow up.

Poster: 149
#877

Which Cementing Technique Provides an Optimal Cement Penetration in Total Knee Arthroplasty?

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Introduction

Achieving a good initial fixation of the Tibial Baseplate (TB) and the Femoral Component (FC) is fundamental for the long term performance of a Total Knee Arthroplasty (TKA). Both cementing technique and cement temperature may influence the penetration depth of the cement, and thus its initial fixation. Previous studies have shown that a cement penetration depth of 3 to 5 mm is optimal. Thicker cement layers (more than 5 mm) increase the risk for thermal damage to bone, whereas thinner layers don't provide sufficient mechanical interlocking. In this study, we compared the cement penetration depth with four different cementing techniques for the FC, five for the TB and two different cement storage temperatures.

Materials & Methods

For each cementing technique, 5 tibial or femoral components were implanted in an anatomical open pore bone

model using standard PMMA bone cement. The cement was manually mixed and applied after 4 min in a doughy state. A constant pressure was then applied for 15 min and after cement polymerization the component was removed. The investigated cementing techniques for the femoral component and for the tibial baseplate and the investigated storage temperatures are listed in Table 1.

The cement penetration was quantified using pictures of a cross-section of the bone models (Figs 1 and 2). The cement layer was identified in several regions of interest (ROI). Based on the number of pixels in the selection, the area of the cement layer in the ROI was calculated, and the average penetration depth was calculated.

Results

Significant differences ($p < 0.05$) were found in average penetration depth at the posterior femoral cut between technique 1 and technique 2 or 3 and between technique 3 and technique 4 (Figure 3). The highest average penetration depth at the posterior cut was found for technique 1.

Tibial cementing techniques A and B were not significantly different from each other in terms of penetration depth but were both significantly different from the other techniques ($p << 0.001$, Figure 4). The same was observed for techniques C and D. The penetration depth was highest for technique E, which was significantly different from all the other techniques ($p << 0.001$).

No significant difference in penetration depth was found between cement stored at 6°C and cement stored at a room temperature of 18°C.

Conclusion

In order to obtain an optimal cement penetration depth of 3 to 5 mm, the following cementing techniques (Table 1) might be preferred. For the femur: technique 1 or 4. For the tibia: technique C or D.

Lowering the temperature of the bone cement doesn't influence the depth of cement penetration. However, this has several advantages such as lengthening the working time of the cement and possibly lowering the peak temperature at the bone-cement interface. Therefore, it might be preferable to store bone cement below room temperature before application.

In conclusion, cementing technique seems to be more important than storage temperature when it comes to the penetration depth of cement into the bone.

Figures

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Figure 7

Poster: 150
#815

In Vitro Knee Kinematics of Unicondylar Knee Arthroplasty

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Introduction

The last years have deepened the knowledge of kinematics before and after implantation of total knee arthroplasty (TKA). It is assumed that unicondylar knee arthroplasty (UKA) features kinematics closer to the natural knee. Functional benefits for UKA have been described in clinical studies. However, there are almost no biomechanical studies to support and explain these findings.

The aim of this project is to determine how knee kinematics before and after UKA compare.

Materials and Methods

Frames with reflective markers were rigidly fixed to tibia, femur and patella of six fresh frozen full leg cadaver specimens and a computed tomography (CT) scan was made. Femur and tibia were embedded, properly aligned in frontal and sagittal planes. The medial and lateral hamstrings tendons were prepared for attachment to constant load springs (50 N each). The quadriceps tendon was prepared to be clamped to a motor. The knees were mounted in a kinematic rig that provides six degrees of freedom to the knee joint. Infrared cameras continuously recorded the trajectories of the markers.

The specimens were subjected to three motion patterns: a passive motion cycle, an open chain extension with 3 kg of load hung to the distal tibia, and a squat between 30° and 120° of flexion with a constant vertical ankle force of 130 N. Based on the CT, models of tibia and femur were made and bony landmarks identified to determine coordinate frames for both bones. The marker trajectories were transformed to anatomical meaningful rotations and translations according to Grood and Suntay.

Tibial axial rotation and ab-adduction, and translations in antero-posterior and medio-lateral direction, were obtained as a function of flexion angle.

After testing the native knee, a medial UKA was performed and the same tests were redone.

Results

Axial tibial rotations and ab-adduction as function of flexion angle are shown in Figure 1. Tibial ab- and adduction at 0° and 90° shows that the knees were well balanced after UKA. Differences in tibial axial rotation and ab-adduction for other flexion angles and in other motions were always smaller than 5° and 2° respectively. Tibial adduction during loaded motor tasks is decreased compared to the native knee due to the discrepancy in stiffness between lateral and medial condyle after UKA. Also the posterior translations of the femoral condyle centers with increasing flexion angle are conserved quite well after UKA.

Discussion and Conclusion

This in vitro biomechanical study showed that knee kinematics after UKA is indeed close to native knee kinematics in a variety of loading regimes.

Figures

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Figure 2

Poster: 151

#961

THA Patients in Standing and Sitting Positions : A Prospective Evaluation Using the EOS Imaging System.

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Introduction:

Most of radiographic analysis of THA patients are based on AP standing X-rays or lying CT scans. Recent literature points out the interest of standing and sitting. Pelvic tilt and sacral slope variations are relevant parameters for planification and navigation. The accuracy of the anterior pelvic plane measures is questionable due to the variations in the quality of lateral standing /sitting X-rays. Hip extension is a key factor in lumbo-pelvic balance; it has been suggested as a significant parameter in THA instability. Using conventional X-rays, it is impossible to evaluate simultaneously hip-spine relationships, THA position and the entire lower limb profile.

EOS® is an innovative slot-scanning radiograph system allowing the simultaneous acquisition of 2 orthogonal images. This study reports the “functionnal” positions of a 150 unilateral THA cohort, including the lateral orientation of the cups and the testing of THA extension.

Methods:

The following parameters were measured: sacral slope (SS), pelvic version (PV), pelvic incidence and anterior pelvic plane (pelvic parameters), sagittal inclination(ASI), frontal inclination(AFI) and planar anteversion (acetabular parameters). Variations of sagittal orientation of the cup were measured on lateral standing and sitting images. Pelvic extension ability was measured using a simple and reproductible protocol; the extension from the hips and from the spine were individualized. The non implanted hips were the control group. Descriptive and multivariate analysis were performed for the different parameters.

Results:

The mean doses for full body were 0.80 mGy ± 0.11 for standing and 0.94 mGy ± 0.21 for sitting. Pelvic incidence was 55.83° ± 11.4.

The inter-interaobserver reliability of measurement ranged from ± 2.97 to ± 6.46. Relevant correlations for pelvic and acetabular parameters could be demonstrated.

The extension test has been conducted in all cases without technical limitation. Values for repeatability and reproducibility are less than 5 °. In the control group, hip extension is 16.04 ° (± 21.80 °) and only 9.49 ° (±9.39°) in THA patients. The spinal extension is 2.40 ° (± 15.36 °) in controls and 2.99 ° (± 11.76 °) in THA patients.

Conclusions:

The EOS® slot-scanning technology offers a significant dose reduction benefits. Collimation of both the beams and detectors minimizes the scattered radiation, while considerably enhancing image quality and avoiding the distortion induced by usual imager systems. The image quality is sufficient to allow a precise analysis of cup parameters even though patients' thickness varies.

A global analysis of the whole body can be performed in the true standing and sitting positions. This study points out standing / sitting variations for pelvis and acetabulum orientations. We observed that the anterior pelvic plane is different from the vertical plane in half cases in standing position. The overall vision of the patients is an improvement to individualize the true hip extension or flexum, and to assess the impact of pelvic tilt. The EOS® imaging system provides new informations regarding the pelvis functionnal anatomy in THA patients with potential applications for the study of unstable cases and wear phenomenons.

Figures

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Figure 6

Poster: 152
#513

Comparison of Joint Line Position Changes After Primary Bilateraltotal Knee Arthroplasty Performed Using the Navigation-Assisted Measured Gap Resection or Gap Balancing Techniques

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Purpose:

This study aimed to compare the clinical and radiological results of navigation-assisted TKAs performed

using the measured gap resection or the gap balancing technique in thirty patients who underwent bilateral primary TKAs.

Methods:

Sixty cases of navigation-assisted TKAs [30 TKAs performed using the measured gap resection technique (Group A) and 30 TKAs performed using the gap balancing technique (Group B)] were analyzed prospectively with minimum follow-up of 2 years. The joint line positions were measured using preoperative and postoperative weight-bearing anteroposterior and lateral radiographs. Clinical results were evaluated using knee scores and functional scores.

Results:

No significant differences in knee scores orfunctional scores were observed. Polyethylene thickness and flexion/extension gaps were significantly larger inGroup B (P\0.05). The meaningful proximal shift of the joint line was shown in Group B (P\0.05).

Conclusion:

The navigation-assisted TKA with measuredgap resection technique could be a useful technique with regard to restoration of the joint line.

Keywords Total knee arthroplasty Joint line position Navigation Measured gap resection technique

Poster: 153
#524

Effect of Extended Trochlear Groove of Femoral Component on Patellofemoral Contact Pressures After Total Knee Arthroplasty

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Polyethylene wear of patellar component is one of the major complications in total knee arthroplasty (TKA). Excessive contact pressure would cause the polyethylene failure. Several biomechanical researches investigated the influence of patellofemoral (PF) contact features on PF contact pressure. However, these studies focused on the design of anterior flange of femoral component. At present, several TKA designs extended patellar groove to distal condyle, expecting to reduce the PF pressure in high flexion angle. Nevertheless, the efficacy of extended groove has not been demonstrated. The objective of this study was to investigate whether extended trochlear groove could decrease PF contact pressure.

In this study, we reconstructed a CAD model of Uknee system (United Orthopedic Corporation, Taipei, Taiwan) including femoral and patellar components, which was defined as baseline model. Based on the baseline model, the trochlear groove was modified to extend to distal condyle of femoral component [Fig. 1]. The modified model was defined as groove extended model. Femoral component and patellar component were aligned in flexion angles of 90° and 120°, and the patellar component was assumed to be placed in the neutral position without rotation. Finite element method was utilized to analyze PF contact pressure. The femoral component was fixed. Then various PF contact forces were applied on the patellar component at each flexion angles. Peak PF contact pressures were compared between the two models.

For the baseline model, Peak PF contact pressure were 124.45 and 141.8 MPa at knee flexion angle of 90° and 120°, respectively. For the groove extended model, Peak PF contact pressure were 105.28 and 120.87 MPa with flexion angle 90° and 120°. With extended groove, the data represented 15.40% and 14.76% reduction of peak PF contact pressure at knee flexion angles of 90° and 120°, respectively [Fig. 2].

This study presented groove extended design could decrease the peak PF contact pressure. However, PF contact pressure in both designs was higher than the yielding stress of UHMWPE. In addition, contact pressure in 120° was larger than that in 90°. This finding may be related to PF contact force and the curvature of femoral condyle. Specifically, at 120°, condylar curvature is increased, leading to less contact area between patellar component and femoral condyle. We suggested that TKA design regarding patellofemoral contact should be further modified to lower wear risk of polyethylene.

Figures

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Figure 2

Poster: 154
#919

Metal Wear Generation From Two Large Diameter Hip Bearing Technologies

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Modern hip arthroplasties utilize metal components which may generate metal particulate debris or metal ions into the joint space from sliding articulation, fretting, or corrosion. Excessive metal debris may cause local tissue reactions and corrode into ions which can be transported throughout the body. Elevated metal ion levels have been measured clinically in blood, urine, and serum analysis for arthroplasty patients and are attributed to wear or corossion of the metallic implant. Excessive metal ions has been linked to various adverse biological responses and should be avoided. Two modern hip bearing technologies were tested and compared for metal wear generation in this study. Current generation metal on metal bearings (MoM) and mobile bearing hips with sequentially crosslinked polyethylene (sxlpe) were developed to combine the benefits of a large diameter bearing and minimize wear compared to conventional hip bearings. MoM hip arthroplasty utilize CoCr ball head and acetabular cup as a bearing interface while the mobile bearing hips utilize a small CoCr ball head articulating against a larger sxlpe femoral head which articulates in a CoCr acetabular cup. A hip simulator was utilized to test these bearings at four cup inclination angles (0°, 35°, 50°, and 65°) which exceed the range recommended for patients. Mom bearings were manufactured from high carbon cast CoCr to typical surface finish and clearances. Mobile beairng hips were commercially available product. Walking profile was applied at 1hz along with 23° biaxial rocking motion. Diluted bovine serum was used to simulate synovial fluid and was collected at every 250,000 cycles. Simulation testing was performed for a total of 2.5 million cycles. The total metal wear generation was analyzed by dissolving the collected serum in acid followed by ICP-OES which has previously been demonstrated to be an appropriate method for metal wear assessment. Total metal wear was calculated by multiplying the measured metal concentration by the volume of lubricant in the testing chambers and dividing by the material density. Cumulative metal wear from each bearing is shown in the table below. Metal wear ranged from 0.04mm3 to 0.09mm3 between all angles for the mobile bearing hip. Wear for the metal on metal bearing varied drastically between the angles starting at 0.59mm3 at 0° of cup inclination to 106.58mm3 at 65° cup inclination. In this study, wear dramatically increased when the metal bearings were tested at 50° or higher inclination angle and confirms the clinical findings that metal wear generation increases significantly for MoM bearings at high inclination angles due to edge loading. The mobile bearing hip does not exhibit this same edge loading wear phenomenon and maintains low metal wear at every inclination angle tested. Both technologies offer the benefits of a larger bearing size and low metal wear, however, high inclination angle must be avoided for metal on metal bearings due to edge loading wear.

Figures

Poster: 155
#591

Revision Total Hip Arthroplasty With Constrained Component for the Unstable Total Hip Arthroplasty

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Purpose:

The purpose of this study was to evaluate the clinical and radiographic results of revision total hip arthroplasty with constrained component in patient with recurrent dislocation or high risk factor for dislocation after total hip arthroplasty.

Materials and Methods:

Between April 1998 and February 2009, 18 patients, who underwent revision total hip arthroplasty with constrained acetabular component, were evaluated clinically and radiographically after a minimum follow-up of two years. There were 8 males and 10 females and the average dislocation were 3.2 times before revision. Mean duration of follow-up was 3.7 years and the average age of patients was 72.3 years. We assessed the relationship between failure of the constrained liner and risk factors for dislocation.

Results:

Harris hip score was improved from average 39.4 points (21-66 points) to 62.2 points (43-86 points). Failure rate of constrained component was 16.7% (2 cases of dislocation, 1 case of loosening need revision surgery). Two of them were revised only polyethylene liner when they have received revision surgery and there was statistical difference between only polyethylene exchange group and acetabular cup revision group ($p=0.03$). There was no difference in failure rate for cemented compared to uncemented liners. There was no case of excessive polyethylene liner wear or osteolysis to the latest follow-up.

Conclusion:

Constrained components could be effective in the treatment of instability following THA, however failure rates are higher than previously expected in our study. When considering constrained component, the surgeon must consider the limitations of these component especially in patients with only had a polyethylene liner exchange.

Poster: 156
#593

Cementless Total Hip Arthroplasty in Patients With Previous Acetabular Fracture

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Purpose:

To evaluate the clinical and radiological results of cementless total hip arthroplasty in patients who had prior acetabular fracture

Methods:

Forty-five consecutive cementless total hip arthroplasty were performed for the treatment of post-traumatic osteoarthritis after acetabular fracture between December 1993 and December 2008. Of these patients, 15 patients were died or lost to follow-up monitoring before the end of the minimum one year follow-up period. We evaluated the clinical and radiographic results of these patients and compared with the results of total hip arthroplasty in patients with post-traumatic avascular necrosis of the femoral head which had without acetabular damage.

Results:

There was no significant difference in clinical and radiographic results between two groups except implanted acetabular component size and required bone graft ($p<0.05$). The Kaplan-Meier ten-year survival rate, with revision as the end-point, was 90% and 96.7% with loosening of acetabular component as the end-point.

Conclusion:

The clinical and radiographic results of cementless total hip arthroplasty in patients who had prior acetabular fracture were satisfactory after average 5.7 years follow-up.

Poster: 157
#876

Unicompartmental Knee Replacement in Patients Aged 70 Years and Older

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Unicompartmental knee arthroplasty (UKA) is an attractive alternative to osteotomy or total knee replacement in middle-aged patient with isolated unicompartmentmental osteoarthritis. Its use in elderly patient is controversial.

The aim of our study was to assess medium to long-term outcomes of UKR with Allegretto resurfacing prosthesis (Zimmer Inc., Warsaw, IN, USA) in patients aged 70 years and older.

27 consecutive medial compartment UKAs performed between 1998 and 2008 were retrospectively evaluated. Mean age was 74 years (range 70-93 years).

Assessment was done using objective examination, KOOS score, WOMAC score, Oxford Knee score, Knee Society Score. Activity level was graded according to Tegner scale. Standard X-rays were performed in order to verify the grade of osteoarthritis in the lateral compartment and the presence of loosening.

Twenty-two patients (81%) were successfully contacted and re-evaluated at 5 years (2 to 9 years). One patient which was 93 years old at the time of surgery died at 36 months following bowel cancer. One patient required conversion to a total knee arthroplasty. Twenty patients showed a statistically significant improvement in all parameters considered. No presence of loosening of the implant was detected at X-Ray and the grade of osteoarthritis in the lateral compartment did not significantly increase.

On the basis of our results, we can conclude that UKR is a safe and clinically effective procedure, which has been proven valuable for the treatment of elderly patients with isolated unicompartmental osteoarthritis. Age more than 70 does not appear to be a contraintication to the procedure.

Poster: 158
#890

Clinical Outcomes of TKA With Flexibile vs. Rigid IM Rod

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Introduction:

Traditional TKA instrumentation relies on the use of an IM rod to establish the valgus angle of the distal cut with little consideration for sagittal alignment. Sagittal alignment of the distal cut influences size and orientation of the femoral component. Anterior femoral bowing may unexpectedly affect implant sizing and consequently patient satisfaction. The purpose of this study was to assess post operative results for patient satisfaction and implant sizing with TKAs performed with a flexible IM rod vs. conventional, rigid rod.

Methods:

Total knee arthroplasty was performed on 100 patients following standard surgical procedure. Rigid and flexible rod utilization was split evenly within this patient group. All patients were followed with SF-36 and KSS satisfaction surveys conducted pre-op and 2yr post-op.

Additionally, 641 total knee recipients from the clinic were followed at the time of surgery. 277 had surgery utilizing the rigid rod and 364 utilizing the flexible rod. The femoral implant component sizing was recorded.

Results:

The average flexible rod KSS pain/motion and function scores increased an additional 4.22 and 3.15 points, respectively, compared to conventional group at 2yr. The SF-36 physical and mental scores increased 3.76 and 3.25 points, respectively. Additionally, flexible-rod-TKA patients showed a lower ROM pre-op, but a 4° higher active ROM post-op.

The implant sizing from the flexible rod trends downward in sizes when compared to TKAs performed with rigid

rod. The incidence of large implant sizes decreased by 14% and middle sizes increased by 13%.

Conclusions:

The results suggest the use of the flexible rod in TKA may improve patient outcomes. Use of the rigid rod may potentially lead to over-sizing and subsequent overhang of the femoral implant. Femoral components implanted with the flexible rod trend to smaller size and thus, smaller ML and reduced overhang.

Summary:

Use of a flexible IM rod to determine implant sagittal alignment improves 2 year clinical outcomes and causes a downward trend in femoral sizing.

Poster: 159
#824

The Use of Vibrational Techniques as a Tool in Total Hip Arthroplasty: How Much Can We Learn From Generic Models?

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There is a growing interest in research on possible applications of vibrational techniques towards solving clinical problems in the field of biomechanics. At the center of all these problems is the objective quantification of the mechanical quality of the bone-implant system (i.e. the fixation), either intraoperative or postoperative. Vibrational techniques allow relating these sought-after mechanical characteristics to a quantity that can be measured during surgery or postoperatively, in casu the modal or dynamic parameters of the system. An important problem however is that it is unknown to which degree **the inherent variability of humans** (E-modulus, density of the bone) has an influence on the vibrational behavior. Furthermore, as the measured dynamics are dependent on the dynamics of the system as a whole, the use of **different types of prostheses** might also have an influence. This work investigates both issues for a stem-type fixation (e.g. femoral component THA) by looking at a generic model, and assesses to what degree conclusions drawn for a simple model can be extrapolated to a realistic model of a bone-implant system.

Materials and Methods

To assess the usefulness of generic models as a predictor of the vibrational behavior in biomechanical systems that rely on a stem-type fixation, a generation of Finite Element models was developed, ranging from a very simple model to a model with a high degree of biofidelity. An overview of the different models can be found in fig.1 and fig 2. This generation of models allows to investigate both the **influence of the shape** and **material properties** of the **bone** (Model 4-5-6), as well as the **prosthesis shape** (Model 1-2-3) on the vibrational behaviour. With regard to the applications, it is important that the generic models are able to predict a change in modal behavior due to a suboptimal fixation, a relevant suboptimal fixation case was chosen (proximal loosening at the metaphysis) [2]. Optimal fixation is defined as the prosthesis in full contact with the bone.

Results and Discussion

For all 6 models the first 20 eigenmodes were calculated, both for an optimal and a suboptimal fixation. The change in vibrational behavior between the two cases is characterized by the change in resonance frequencies. Fig. 3 summarizes these changes for the different models. Generic models are able to predict the sensitivity of torsional modes and bending modes to changes in the contact conditions. However they overestimate the sensitivity and fail to predict the correct mode order of the most sensitive modes. Furthermore it is found that the simplest cylindrical model is not a good predictor of the modes that show the highest sensitivity, and that taking into account the bent character of the prosthesis shape is important to obtain better comparability. Generic models are by themselves not accurate enough to simulate the complex vibrational characteristics of a realistic femur-

implant combination and although trends can be deducted from generic models, numerical development of intraoperative tools based on vibrational techniques should always include simulations on realistic models.

[1] Dujardin et al., *Clin. Orthop.* **325** (1996), pp. 276–286

Figures

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Poster: 160
#1014

A Pilot Study Investigating the Use of at Home Web-Based Questionnaires Compiling Patient Reported Outcome Measures Following Hip and Knee Replacement Surgery

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A pilot study investigating the use of at home web-based questionnaires compiling patient reported outcome measures following total hip and knee replacement surgery

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Background:

Patient related outcome measures (PROMS) have been introduced as a part of routine NHS joint replacement. Patients are invited to fill in pen and paper questionnaires pre operatively and then at agreed postoperative intervals. Data collection can be time consuming for both patient and clinic staff, requires subsequent interpretation and documentation and may even necessitate otherwise unnecessary hospital visits.

The web site ‘myclinicaloutcomes.com’ was introduced in 2011 providing a web based PROM tool with patients invited to complete questionnaires at home with results available to their attending surgeon. The purpose of the current study is to determine if an at home web based PROMS tool provides a satisfactory patient compliance level and whether compiled data is equivalent to pen and paper clinic PROMS data.

Methods:

A single surgeon series of 82 patients who had undergone joint replacement surgery over a one-year period were identified. 43 knee replacements and 39 hip replacements with mean age 68.5 years (range 55-86) and 67.4 years (range 40-83) respectively. Each patient was contacted by mail inviting him or her to register and then complete an Oxford score on the myclinicaloutcomes.com web site. 2 weeks following initial mailing a second request was sent to those failing to initially respond. Telephone contact was then made to those continuing not to have responded enquiring as to the reason for non-response.

Successfully collated on line Oxford scores were compared with previously recorded pen and paper scores for each patient from a prospectively updated database.

Results:

22 of the invited 82 patients registered with the web site (26.8%). 1 patient insufficiently filled in the online tool failing to provide an Oxford score. 7 patients contacted the unit during the study to explain they could not fill in the online survey, 6 lacking internet access and 1 due to ill health. Telephone contact was achieved with 34 of the remaining 53 patients. 28 reported no Internet access, 2 had not received a letter, 2 due to health issues, 1 forgot and another claimed logging in issues.

Available Oxford scores obtained from the website revealed a mean score of 30.1 (SD 11.4, range 9-47) which was comparable with mean database score for the respective patients of 29.1 (SD 11.8, range 9-48). Further analysis revealed a mean age of 67.4 years for those successfully able to utilise the web site. Mean age of the non-responder group was 67.0 with Oxford scores retrieved from the database of 35.6 hip (SD 10.4, range11-48)and 29.0 knee(SD 11.1, range 6-46).

Conclusion:

This pilot study reveals a poor compliance for patients invited to fill in a web based patient related outcome measure questionnaire with only 26% successfully completing a score. Available web based scores are however comparable with hospital pen and paper scores. Compliance issues might be improved with further patient education and encouragement with regard this new resource. 34 of the 82 (41%) patients did not however have access to the Internet and until universal home access is available, compliance may remain an issue particularly in this frequently elderly population.

Poster: 161
#870

Obesity and Primary Joint Replacement Surgery. a 1-Year Retrospective Review.

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Introduction

Obesity is described as 'endemic' in western society. An increased Body Mass Index (BMI) results in an increased risk of developing osteoarthritis and therefore subsequent requirement for joint replacement surgery. Concern exists as to the safety and efficacy of joint replacement surgery in the obese patient. Added to this, health service providers are constantly looking to reduce costs and "rationing" of joint replacement surgery to patients with a high BMI is one proposed option. The aim of this current study is to investigate if a raised BMI affects the perioperative management of hip and knee replacement surgery and the subsequent short-term clinical outcomes.

Material and methods

A retrospective review of 73 consecutive patients undergoing primary joint replacement surgery by a single surgeon over a 12-month period was performed (30 total hip replacements (THR) and 43 total knee replacements (TKR). Mean age for both TKR and THR groups was 68 years. Patients were divided into BMI groups of <30kg/m^2 normal, 30-40 kg/m^2 obese and >40 kg/m^2 morbidly obese. Detailed information was collected including hospital length of stay, operative tourniquet times for TKRs and perioperative complications. Pre- and post-operative Oxford scores were retrieved from a prospectively updated database.

Results

33 patients were non-obese (16 TKR and 17 THR), 37 patients obese (24 TKR and 13 THR) and 3 patients morbidly obese (3 TKR). Detailed review of TKR patients identified significantly different pre operative Oxford scores with the mean score for non-obese patients 22.5, obese 13.9 and for the 3 morbidly obese patients 8.67($p=0.0017$). Mean operative tourniquet time for the non-obese was 62.5mins and 59.2mins for the obese groups ($p=0.22$). Interestingly the median femoral implant size was 3 irrespective of BMI group. Postoperative hospital stay was significantly longer for the obese group at 8.3 days versus 5.1 days for the non-obese ($p=0.02$). 6-week postoperative Oxford knee scores were not significantly different with mean scores of 28.6 and 24.6 for the non-obese and obese groups ($p=0.13$) with mean score improvement of 9.2 and 11.1 respectively ($p=0.35$). THR review identified no significant difference between pre op scores for the non-obese and obese groups (15.8 & 17.0, $p=0.29$). Postoperative stay was 5.8 and 7.5 days respectively ($p=0.09$). 6 week post operative scores were 40.2 and 33.3 ($p=0.04$) with mean score improvement 24.4 and 16.4 ($p=0.02$) Like TKR, the mean implant size for THR had the same between groups with median acetabular size of 52. Perioperative complications were 1 wound haematoma in the THR non-obese group, multiple pulmonary emboli in a post pulmonary lobectomy patient in the TKR obese group and delayed discharge for an obese THR patient due to abdominal distension.

Conclusions

This 1-year retrospective review of 73 consecutive primary joint replacements identified that the majority of patients were obese or morbidly obese (55%, 40/73). Irrespective of BMI, patients can expect a significant

improvement in Outcome score even in the short term. Scores were however significantly improved in the THR non-obese group compared to the obese group. Neither surgical time nor complication rate is increased for obese patients however postoperative length of stay is lengthened suggesting rehabilitation is slower.

Poster: 162
#717

Condylar Differential in Planned Tibial Cuts in Total Knee Replacement: An Alternative to Computer Navigation

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Introduction:

Mechanics and kinematics of the knee following total knee replacement are related to the mechanics and kinematics of the normal knee. Restoration of neutral alignment is an important factor affecting the long-term results of total knee rereplacement. Computer-assisted surgery facilitates the surgeon an additional measure by providing alignment of the knee joint.

Tibial cut is a vital and crucial step in ensuring adequate and appropriate proximal tibial resection, which is essential for mechanical orientation and axis in total knee replacement. Tibial cut must be individually reliable, reproducible, consistent and an accurate predictor of individual anatomical measurements.

Conventional tibial cuts of tibia with fixed measurements cannot account for individual variations. While computer navigated total knee replacement serves as a medium to achieve this objective, the technology is not universally applicable for differing reasons.

Therefore we evolved the concept and technique of Condylar Differential for planned tibial cuts in conventional total knee replacement, which accounts for individual variations and reflects the individual mechanical orientation and alignment.

Methods:

We used the Condylar Differential in 37 consecutive total knee replacements since August 2009. We also applied the technique in valgus knees and severe advanced osteoarthritis.

First a vertical line is drawn on the digital weight bearing anteroposterior radiograph for mechanical axis of tibia. Then a horizontal line is drawn across and perpendicular to the mechanical axis of tibia. The distances between the horizontal line and the lowest reproducible points of the articular surfaces of the medial and lateral tibial condyles respectively are measured. The difference between the two measurements obviously represents the Condylar Differential. Condylar Differential measurement technique is illustrated in Figure 1.

Condylar Differential, adjusted to the nearest millimetre, is maintained in executing the tibial cuts, if necessary successive cuts.

Results:

Condylar Differential measurement showed a very wide variation, ranging from 8-6 (2 mm) to 10-0 (10 mm).We found that prior measurement of Condylar Differential is a simple, consistent and effective estimate and individualises the tibial cut for optimal templating of tibia in total knee replacement.

We encountered no problems, adopting this technique, in our consecutive series of total knee replacements. Preopertative and postoperative radiographs of total knee replacement in a knee with advanced osteoarthritis, applying Condylar Differential, are also attached in Figure 2 and 3. This patient is also happy and currently waiting for contralateral knee replacement.

Conclusions:

Condylar Differential contributes to optimal individualised tibial cut in conventional total knee replacement and is a useful alternative to computer navigated option with comparable accuracy in this respect.

While we used the technique of Condylar Differential in digitised radiographs, this technique can also be applied to plain films, allowing for the magnification.

Clinical Relavance:

Condylar Differential could prove to be a useful alternative to computer navigated option in conventional total knee replacement . In addition, this technique can be adapted to unicondylar knee replacement.

Figures

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Figure 6

Poster: 163
#519

A Case of Scapulothoracic Dissociation With Brachial Plexus Injury

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Introduction

The rare condition of scapulothoracic dissociation (STD) is characterized by a lateral displacement of the scapula from the thoracic cage following severe trauma to the scapular girdle. Vascular and brachial plexus injuries associated with this injury are potentially life threatening and poor outcoming. It was formerly considered analogous to a closed forequarter amputation until 1984, when Oreck et al first identified this injury pattern.

A traction injury in a major trauma injury is the main mechanism, which make the force been transferred to the anterior shoulder and results in complete disruption of the scapulothoracic articulation. The key to the diagnosis is accurate interpretation of the radiographs: the lateral dislocation of the acromion and lateral shift of the medial scapular border are evident on chest radiographs . The initial eluviations of this injury is to keep the life-support cares, then stabilization of bony structure and necessary nerve or vascular repair are performed after neurovascular survey in the orthopedic management.

We report one case and outcome follow up with literature review serve to highlight the current management of this unusual injury.

Case report

A 41-year-old male drove his motorcycle and hit to a dozer and been thrown to ground in a motor vehicle accident. After first emergency resuscitation, x-ray and the three-dimensional reconstructed computed tomography (CT) demonstrated right scapulothoracic dissociation with lost of sensory and motor with multiple limb fracture were also noted.

Results

The LCP (locking compression plate) was fixed with a debridement (hematoma clear and muscular repair) on this patient. Electromyography and nerve conduction studies and MRI of shoulder showed and confirmed nerve lesion over proximal part of the brachial plexus. The follow up x-ray showed reduced scapulothoracic position and he was taken follow up in out-patient service and recovery of sensory for right forearm on the 2 months later, motor lost especial elbow flexion was still not recover until 3 months.

Discussion

Scapulothoracic dissociation is an extremely rare injury and results from severe violent traction or blunt force to the forequarter and transmitted to chest wall. Multiple muscular tear with brachial plexus avulsion injury are should keep in mind for detail clinical findings and radiological studies.

Then a quick and thorough neurologic examination with special attention to the injured extremity should be

performed preoperatively. Arteriography and 3D CT for bony construction to identify of possible nerve or vascular injury in the hemodynamically stable patient. After confirming partial avulsion of brachial plexus injury, primary repair and nerve exploration will be suggested because functional recovery of the extremity will occur. Musculotendinous transfers maybe performed at a later time if necessary.

We should keep in mind that the STD will be happened in a major trauma accident because prompt diagnosis and management of the neurovascular injury may optimize the outcome of the patients. Early and appropriated orthopedic stabilization of the shoulder girdle is important for stable support of the shoulder girdle including the neurovascular structures

Figures

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Poster: 164
#520

Outcome of Spondylolytic Defect With a Modified Wiring-Pedicle Screw Reconstruction Technique: A 3 - Year Experience in Taipei City Hospital

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Introduction

To evaluate the clinical effect of pedicle screw+tension band wire (modified van Dam procedure) technique for direct repair of lumbar spondylosis in young patients.

Methods

Clinical and radiological results of surgical repair in 38 patients at a minimum follow-up of 18 months with lumbar spondylosis were treated with isthmic debriment, local bone graft and fixation by modified van Dam technique.

Results

All patients were followed up for 18-36 months, 26 on the average. The lower back pain disappeared in 35 patients. According to the Oswestry score, the result were excellent in 32 cases, good in 3, fair in 3, and the excellent and good rate was 92.1%. No looseness over pedical screw but 2 breakages on wire was found. The X-ray showed that the spondylolysis got fusion in 36 cases. However, revised CT scanning among 14 patients after a mean of 18 months revealed complete healing of the fracture in 10 patients, partial in 2 and non-union in 2.

Conclusion

The pedicle screw+tension band wire (modified van Dam technique) for direct repair of lumbar spondylosis is effective and requires simple manipulation. This technique would be also useful for fusion of the pars defect.

Poster: 165
#518

Irreducible Acute Anterior Shoulder Dislocation Due to Rotator Cuff Tear and Associated Fracture of the Greater Tuberosity: The Double Row Repair Technique

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Introduction

Difficulty in reduction of close shoulder dislocation is often seen in ER or OPD, not well sedation or pain control to patient is a impact factor for succeed close reduction. However, failure in closed manipulative reduction of an acute anterior shoulder dislocation is rare. This condition is usually due to a structural block happened in shoulder

joint by bony defect or soft tissue impingement. We reviewed 8 cases of anterior shoulder dislocation with associated rotator cuff tear and fracture of the greater tuberosity. These dislocations was irreducible using standard closed methods. We use a double row repair for rotator cuff tear and fracture of great tuberosity.
Materials and Methods. A 60-year-old female visited our ER following a fall down from motorcycle. Several attempts at closed reduction under sedation, failed in the emergency room. X-ray showed great tuberosity fracture with anterior dislocation. So operation was performed. The shoulder was explored through a muscle splitting incision to a standard deltopectoral approach. On exposing the humeral head, a complete avulsion of the supraspinatus tendon with bony attachment was found. An avulsion of the greater tuberosity fragments was also noted. The posterior periosteal sleeve was intact. The reason of irreducible anterior dislocation of shoulder is due to anterior glenoid rim had deeply wedged into a triangular defect in the posterior humeral head. Then the dislocation was reduced the fractured tuberosity and the rotator cuff avulsion was repaired using a double row repair technique. (The anchors and screw with multiple oblique Ethibond No. 2 mattress sutures to the rotator cuff). Since 2008.July to 2010.Jan, 8 patients was diagnosed dislocated with greater tuberosity fracture and difficulity in reduction under regular technique. double row repair technique was perforemd and then follow up in outpatient department.See Figure 1 , 2

Results

All patients were recovery to 85-96% ROM under average follow-up 7 months. X-ray showed well union for fracture and good to excellent pain recovery.

Discussion

Closed reduction of an acutely dislocated shoulder is usually successful. The reported causes of irreducible dislocation include bowstringing of the subscapularis or bicipital tendon; impaction of the greater tuberosity into a Hill—Sachs lesion; interposition of a ruptured subscapularis in the glenoid rim. We reviewed 8 cases of irreducible anterior shoulder dislocation and repair both rotator cuff tear with great tuberosity fracture using double row repair. We found this technique is useful and easy in fixation of greater tuberosity fracture with repairing rotator cuff tear.

Figures

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Poster: 166
#538

A Cause of Anterior Thigh Pain After a Dissociated Pelvic-Sacral Joint; Management and Literary Review

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Meralgia paresthetica is an entrapment neuropathy of the lateral femoral cutaneous nerve (LFCN). When the LFCN is entrapped, paresthesias and numbness of the upper lateral thigh area are the presenting symptoms. In most cases, the cause is considered to be idiopathic entrapment of the lateral femoral cutaneous nerve. These causes of meralgia paresthetica have ranged from chronic disturbance of the nerve due to a tense inguinal ligament in the case of a leg-length discrepancy; tight trousers; wallet carried in front pants pockets; obesity or pregnancy; or a mass compressing the nerve. In the case presented here, a trauma induced pelvic fracture and displaced pelvic-sacral made a complicated problem after an operation for reduction. This case with symptoms of meralgia paresthetica underwent local injection and nerve release then symptom relief.
materials and Results

A 49-year-old female suffered from a pelvic fracture after a traffic accident. Pelvic fracture with displaced was diagnosed and then underwent reduction operation. However, she then suffered from severe thigh pain and temporary numbness. Examination revealed decreased touch and pain sensation in the anterolateral aspect of left

thigh, forceful palpation over a point 2 cm distal and 2 cm medial the right anterior superior iliac spine produced pain and numbness, consistent with a left neuropathy of the lateral femoral cutaneous nerve. In our hospital, a local injection with Rinderon mixed with Lidocain was performed at the iliac fracture lesion and nerve release by approach from last operative site. After these management, temporal pain relief but little numbness was still noted. After 4 weeks local injection, the all symptoms were relief.

Discussion

Meralgia paresthetica this term from the Greek "meros" for thigh and "algia" for pain consists of unpleasant burning pain. Entrapment

neuropathy of the lateral femoral cutaneous nerve was first described by Hager in 1885 and termed meralgia paresthetica" by Roth in 1895.Since then, many clinical reviews have been published regarding the reasons for irritation over the lateral femoral cutaneous nerve. However, many articles on meralgia paresthetica were published during the first half of the 20th century, but despite such early and widespread recognition, it has since become an obscure diagnosis. Few practicing physicians today seem to be aware of the condition or recognize the symptoms. Diagnosis is mainly based on history and physical examination. Patients typically describe burning, coldness, lightning pain, deep muscle aching, tingling, frank numbness, or local hair loss on the anterolateral thigh. The symptoms may be mild and may resolve spontaneously or they may severely limit the patient for many years. Macnicol and Thompson reported that surgical treatment would provide satisfactory results as long as it took place within 18 months from the beginning of the symptoms. Edelson and Stevens reported that nonoperative treatment did not lead to long-lasting relief, whereas surgical decompression led to excellent or good results. In our experience, the differential diagnoses is important and sometimes the lumbosacral disk syndromes need to be considered. Local injection was pain relief but surgical decompression if nonoperative treatment failed.

Poster: 167
#878

In Vitro Evaluation of Hip Joint Contact Areas During Pivoting Motion

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Introduction

The understanding of hip joint kinematics and its influence on hip pathologies – and vice-versa - is quite lacking. Rydell et al. reported that the hip acts more as a gimbal joint rather than a true ball-and-socket joint [1]. Safran et al. [2] measured not negligible displacements between femoral head and acetabulum during passive manoeuvres on cadavers. Further efforts are needed to understand how the interface between the femoral head and the pelvic acetabulum works during hip physiological motion. The goal of our study is to assess the displacement between the acetabular centre and the femoral head centre in relation with the localized contact areas during hip pivoting motion.

Materials and Methods

Eight not-pathologic hips were used for this study. A commercial navigation system (BluIGS, Orthokey, USA) was used to evaluate the anatomic and kinematic data. The surgeon acquired the kinematics and the anatomy required to model the anatomical surfaces. Each pivoting motion was subdivided in 3 subsets, in order to evaluate the intra-trial reliability. An approximate surface was generated using a recursive method for both for the acetabulum and the femoral head, with the underlying hypothesis that both the articular surfaces were spherical.

Figure 1. Acetabulum clock scheme (2a). Distribution of contact areas in all evaluated hips (2b) .

We computed the distances between the centres of the spheres that approximate the acetabulum and the femoral head. In order to quantify the reliability of the performed movements we evaluated also the correlation functions for the joint clinical angles (flexion/extension, abduction/adduction, internal/external rotation) and the centres displacements (anterior/posterior, medial/lateral, proximal/distal), among the three subsets of data. We evaluated the minimum distances between the approximated spheres of the acetabulum and of the femoral head during the pivoting motion. In order to clearly indentify the localization of the contact area within the acetabulum we used the "clock representation" (figure 1a).

Results

The evaluation of the correlation function for angles and displacement, suggested an excellent repeatability of the pivoting movements (correlation function between 0.71 and 0.99). The contact areas were manly concentrated from 7 o'clock and 10 o'clock in the clock scheme (figure 1.b). The analysis of the displacements between the acetabulum and femoral head centre underlined a predominant distance in medial/lateral direction; specifically the mean(±SD) distance was 3.4±0.2 mm in medial/lateral direction, 1.5±0.2 mm in antero/posterior direction and 1.5±0.2 mm in proximal/distal direction (figure 2).

Figure 2. Femur displacement respect to acetabulum centre in medial/lateral, antero/posterior and proximal/distal direction.

Discussion

Our results confirmed that the joint analysed is not a perfect ball-and-socket joint since the displacement between the acetabular centre and femur centre is not constant, and since the contact areas are not-uniformly distributed. In the future could be interesting to integrate MRI images and computer simulations in order to analyse pathological hips with the possibility to improve surgical techniques.

References

[1] Rydell N, Biomechanics of the Hip Joint , Clin Orthop Rel Res 92:5-15,1972

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Figures

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Poster: 168
#924

Intra-Operative Validation of a Novel Method Dedicated to Quantify Pivot-Shift Phenomenon

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Introduction

Recently Pivot-Shift (PS) test is becoming the benchmark used to evaluate dynamic knee instability that is strongly correlated with anterior cruciate ligament (ACL) injury [1]. The main problem in using PS test is the difficulty of quantifying the test by means of specific parameters: PS still remains a surgeon-subjective assessment. Moreover the load and movement application are not constant and not easy to quantify [2]. This study aimed to intra-operatively validate a non-invasive method able to quantify PS test results; validation performed by means of a navigation system.

Materials and methods

We recruited 15 consecutive patients with an acute or chronic ACL injury. During the surgery the same expert surgeon performed 3 times the PS test before the ACL reconstruction acquiring the limb kinematics by means of a commercial navigation system (Klee, BluIGS, Orthokey LLC, DE, USA) [3]. Before the tests, an additional optical tracker was mounted on a dedicated custom-made and sterilizable box containing a commercial triaxial accelerometer (Kira, Orthokey LLC, DE, USA). The box was skin-fixed to the tibia by means of a sterile drape. The second derivative of the tracker position - using the antero/posterior tibial anatomical axis direction as reference - was evaluated. For all the tests we estimated the maximum (***MAX***) and the minimum (***min***) value of the acceleration during test and the whole range (***Range***). Soft-tissues artifacts and measurement agreements between the parameters estimated by the two systems were evaluated (P = 0.05).

Results

Mean RMSE obtained during PS test and due to soft-tisse artifact was (5.1 ± 2.3) mm over the whole set of repetitions; maximum error was reached when the limb was flexed at (80.2 ± 6.2) degrees. The obtained agreement results are reported in figure 1.

Figure 1: Agreement Results for MAX, MIN and RANGE.

Conclusion

We demonstrated the reliability of the new method by means of a commercial navigation system as gold-standard. The quantified parameters could be used also during surgery or in post-op control to assess the restoration of healthy controlateral dynamic stability of reconstructed knee. Further analyses have to be performed.

References

1. MS Kocher et al., Am J Sports Med, 2009.

2. CG Lake et al., J Am Acad Orthop Surg, 2008.

3. Lopomo et al., J Orthop Res. 2009.

Figures

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Figure 2

Poster: 169
#768

Volumetric Wear of Retrieved Metal-on-Metal Hip Resurfacing Components

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Recent advances in hip arthroplasty have allowed the operation to boast excellent results and high survivability. However, higher revision rates were seen amongst younger, more active patients. The hip resurfacing was designed as a low wear alternative to total hip replacement and targeted specifically at the younger patient.

Wide revision rates have been reported amongst different designs of hip resurfacing. In 2010, the British National Joint Registry recorded 5-year revision rates of 4.3% for the Birmingham Hip Replacement (BHR), but 12.0% for the Articular Surface Replacement (ASR). This compares to 2.0% and 3.4% for cemented and cementless metal-on-polyethylene (MoP) total hip replacement respectively. Given the patient group, it may be expected that resurfacing devices would suffer a higher revision rate than total hip replacements. However, the wide range amongst resurfacings is of concern.

It has been reported that many revision take place due to adverse reactions to metal debris, caused by wear of the components. Wear has also been correlated with patient metal ion levels, with a concern about the long-term health effects of high levels. Device wear is therefore an important issue affecting both the short- and long-term survivorship of hip replacements and minimising wear should be a priority.

In all but a handful of cases, wear of explants has previously been measured by the maximum depth. However, this can give misleading values and, in reality, wear is a volume and should be measured as such. This study applied a novel technique for assessing volumetric wear using a Mitutoyo LEGEX322 co-ordinate measuring machine (resolution within 1µm) to 66 retrieved hip resurfacing devices (66 heads, 66 cups) from 4 designs.

Mean wear rates ranged from 8.9mm^3/year (Corin) to 19.4mm^3/year (Articular Surface Replacement [ASR]), with intermediate values for the Durom (9.9mm^3/year) and Birmingham Hip Resurfacing (BHR) (12.2mm^3/year). Clearly these are significantly higher than rates expected from simulator studies and the subsequent increase in patient metal ion levels from wear debris is a concern. In most cases, the majority of wear took place on the head. However, the ASR cup, which is heat treated, showed a significantly greater wear rate than the other devices.

Previous work has shown that a shallower cup, such as that employed in the ASR, can lead to an increased risk of rim loading in poorly positioned implants. High wear rates were commonly seen in ASR devices with high inclination and anteversion angles. Similarly positioned components in other devices did not show the same risk of high wear.

Although the ASR is no longer on the market, important lessons can be learned from the study of failed devices. By linking back to design features (such as cup coverage and manufacturing process), identifying differences in the performance of different designs can inform future models and allow them to perform to an improved standard.

Poster: 170
#884

Analysis of Failed Ex Vivo 36mm Metal-on-Metal Pinnacle Hips

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Introduction

Metal-on-metal (MoM) total hip replacement (THR) has undergone a renaissance with it accounting for 35% of procedures in the US in 2009. Most MoM THRs are 28 or 32mm in diameter but recent devices have been made at 36mm diameter or larger to reduce dislocation rates and improve lubrication.

Materials and methods

From a cohort of 640 patients, each implanted with a Corail Pinnacle 36mm MoM THR, 19 pairs of femoral heads and matching acetabular cups were obtained at revision surgery. All 19 patients who were revised reported pain. Full patient details were available including blood metal ion concentrations. In the wider patient cohort patients were assessed using Harris Hip and UCLA activity scores. One hundred and twenty patients have also attended for metal ion analysis following implementation of a mass screening program. All *ex vivo* components were examined using a Mitutoyo Legex 322 co-ordinate measuring machine (CMM) (sensitivity better than 1μm) to determine their wear. The roughness of the articulating surfaces was measured using a ZYGO NewView 5000 profilometer (1nm resolution). This data then allowed the theoretical lubrication regime to be identified.

Results

From the articulating surfaces, a range of wear volumes per component were measured, from 1 to 18mm^3. The paired head plus cup wear volumes ranged from 3 to 23mm^3. Femoral head wear rates were usually greater than cup wear rates, means of 0.21mm^3/month and 0.06mm^3/month respectively being measured. Of the explants, 15 pairs were found to have low bearing surface wear rates of <3mm^3/year. In each of these cases, significant damage was identified at the internal taper junction of the femoral heads. Roughness values of the articulating surfaces were typically in the range of 0.010 to 0.030μm Ra, so that the implants were operating under mixed lubrication. Articulating surface roughness measurements showed little increase over unworn areas. In total, 28 patients have been revised or listed for revision due to Adverse Reactions to Metal Debris (ARMD). This represents an overall failure rate of 4.4% at mean 3.5yrs (range 1.8-5yrs). Blood Cobalt (Co) and Chromium (Cr) concentrations were generally low, with higher levels associated with acetabular cups with low inclination and low anteversion. Median cup inclination/anteversion angles in the ARMD cases were 46° and 11°. X-rays showed in some cases a characteristic pattern of femoral loosening.

Discussion

To the authors' best knowledge this is the first time that the ex vivo wear volumes and wear rates of these modern 36mm MoM THRs have been reported. It is also one of the first papers to report on taper wear. The low wear of

the articulating surfaces corresponded with the relatively unchanged values of surface roughness. Mechanical failure at the head/stem interface appears to be a critical factor in the development of adverse reactions following MoM THR. Paradoxically taper failure is associated with low cup inclination and anteversion. Taper damage should be considered as another potential source of metallic debris alongside that which may originate from the articulating surfaces.

Poster: 171
#875

Excessive Failure Rates of the Asr Resurfacing and Large Head Metal on Metal Hip Prosthesis

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Background

The worldwide withdrawal of the DePuy Articular Surface Replacement (ASR) device in both its resurfacing and total hip replacement (THR) form on 26 August 2010, after almost 100,000 were implanted worldwide, has had major implications. At that time, data from the 2010 National Joint Registry for England and Wales was quoted and figures of 12% (resurfacing) and 13% ("large head" 'XL' THR) failure at five years were offered as a reason for withdrawal of the ASR.

Methods and materials

In 2004 a single surgeon prospective study of the ASR bearing surface was undertaken. Presented are the Adverse Reaction to Metal Debris (ARMD) failure rates of the ASR resurfacing and ASR THR systems. The diagnosis of ARMD was made by AVFN and was based on clinical history, examination, ultrasound findings, metal ion analysis of blood and joint fluid, operative findings and histopathological analysis of tissues retrieved at revision. Cobalt and chromium metal ion concentrations were determined using inductively coupled plasma mass spectroscopy (ICPMS). Acetabular cup position in vivo was determined using EBRA software. Mean follow up was 52 months (24 – 81) and 70 patients were beyond 6 years of the procedure at the time of writing. Kaplan Meier survival analysis was carried out firstly with joints designated “failure” if the patient had undergone revision surgery or if the patient had been listed for revision. A second survival analysis was carried out with a failure defined as a serum cobalt concentration > 7 microgrammes/L (MHRA guideline from MDA-2010-069). Full explant analysis was carried out on retrieved prostheses. This analysis included wear volumes measured from the articulating surfaces, as well as taper junctions on THRs, using a co-ordinate measuring machine with a scanning head (Mitutoyo Legex 322, manufacturer’s claimed accuracy 0.8μm). In addition, roughness measurements of the articulating surfaces were determined using a non-contact profilometer (ZYGO NewView 5000, 1nm resolution). Roughness values were used to calculate the theoretical lubrication regimes of the prostheses at time of retrieval.

Results

There were 505 ASR hips in total (418 resurfacings and 87 THRs). 657 metal ion samples were available at the time of writing. Survival analysis using revision/listed for revision as end point (at 6 years): ASR resurfacing: 26.1% failure; ASR THR: 55.5% failure. Survival using ion analysis (at 5 years): ASR resurfacing: 50.1% failure; ASR THR: 66.5% failure. The median (range) volumetric wear rate of failed prostheses was 8.23mm^3/ year (0.51 – 95.5). Roughness measurements in the worn regions of the articulating surfaces had increased over unworn areas. Theoretical lubrication analysis indicated a shift from fluid film to boundary lubrication. Operating under boundary lubrication helps to explain the high wear rates seen on explanted components, high ion concentrations measured in the blood of patients and the tissue destruction seen at revision surgery. Failure and high ion concentrations are linked to acetabular cup size, anteversion and inclination. Increased failure rates in THRs were due to wear at the taper junction of head and stem.

Poster: 172
#874

Analysis of Ex-Vivo Knee Prostheses

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Introduction:

There are financial, social and clinical needs for a thorough investigation into the failure modes of Total Knee Replacements (TKRs) to help support future developments in superior prosthesis design and surgical techniques.

Methods and Materials:

Ten retrieved TKRs of various designs have been received and five have been analysed. All prostheses have CoCr femoral components and fixed UHMWPE tibial components, and include cemented and cementless designs. Time in vivo was up to 20 years.

Surface topography measurements of S_q, S_a and S_{sk} were taken for the articulating and backside surfaces using a non-contacting 3D interferometic profilometer. Surface analyses on the UHMWPE tibial components were performed according to the methodology described by Hood et al[HYPERLINK "create.php %2525253FisAbstract=Abstract" \l "_ENREF_1" \o "Hood, 1983 #202" 1]. Patient details of age, gender, duration in vivo and knee scores were recorded.

Results:

Figure 1 shows the surface roughness results for the articulating surfaces of the CoCr femoral components and the matching UHMWPE tibial components, alongside the surface evaluation scores for the UHMWPE tibial components. The mean damage score based on the Hood et al[HYPERLINK "create.php %2525253FisAbstract=Abstract" \l "_ENREF_1" \o "Hood, 1983 #202" 1] technique was 56 with burnishing and abrasion being the most prevalent damage modes identified on all prostheses, embedded debris was the least prevalent but still identified on more than half the cohort.

Discussion:

As expected the surface roughness values were greater for the worn areas of the femoral component compared with the unworn areas and the same was true for all except one of the UHMWPE components, K005. The surface skewness for the worn areas was negative for all femoral components as expected and for all except for the UHMWPE component of K005.

The mean damage score for the UHMWPE components of 56 was greater than the mean damage score of 28 across a cohort of 48 prostheses reported by Hood et al[HYPERLINK "create.php %2525253FisAbstract=Abstract" \l "_ENREF_1" \o "Hood, 1983 #202" 1]. Figure 2 shows a worn UHMWPE tibial tray with macroscopic delamination visible on the posterior medial edge, the overall Hood score for this joint was 66.

Few studies have taken surface roughness measurements of the femoral components of TKRs and none have used a non-contacting profilometer. Lakdawala et al[HYPERLINK "create.php%2525253FisAbstract=Abstract" \l "_ENREF_2" \o "Lakdawala, 2005 #150" 2] used a contact stylus profilometer and showed no differences in surface roughness between articulating surfaces and controls (n=22). Our initial results indicate an increase in surface roughness between worn and unworn areas of the femoral component.

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Figures

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Poster: 173
#803

Fighting Implant Associated Infections: Review and Outlook of Concepts Based on Natural Antimicrobials and Silver Coatings

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Medical-device-related bacterial infection and biofilm formation on, e.g. catheters, pacemaker leads, or hip implants is a major health care problem with adverse impact on the quality of life of patients and high economic costs. The incidence of implant infection depends on many factors, such as operation procedure and facility, site of implantation, patient related factors and medical care quality. Two steps are usually distinguished in the process of bacterial adherence to an implant surface: first the bacteria adsorb in a competitive manner with host cells to implant surfaces, and second, they proliferate, cluster and engulf themselves in an exopolysaccharide matrix into biofilms. Infection of medical devices is facilitated by the injury caused by the medical device and the low tissue integration. It may occur early after implantation, probably due to peri-operative contamination, or at later stages due to inoculation of low virulent bacteria during surgery or hematogenous infections. Infections associated with devices are most frequently caused by *S.aureus* (30%), coagulase-negative staphylococci (22%) or Gram-negative bacilli (10%), and rarely by anaerobes, enterococci and streptococci (1 to 5%). It is suggested that approximately 30% of the infections have a polymicrobial origin. Upon infection, therapies are applied that are based on high-dose delivery of antibiotics for several weeks and along with a temporary implant removal for the duration of the therapy.

The prevention of bacterial colonization of surfaces has been attempted using a range of diverse approaches. Immobilization of pharmaceutical active compounds has been often attempted and is used, including most recently immobilization of fall-back antibiotics. At this point, it is important to mention that the use of fall-back antibiotics as active substance immobilized on permanently implanted devices is extremely risky and should not be used routinely in the clinical setting since it could lead to an immediate bacterial resistance. Furthermore, it is of utmost importance to understand the exact mode of action of the pharmaceutical compounds. Only with that knowledge it is possible to select the proper immobilization scheme.

In our presentation we will elucidate on these reflections and exemplify different schemes using natural antimicrobial compounds, i.e. furanone and serrulatanes, and compare them to traditional antibiotics immobilization and the use of silver. Furanones, secondary metabolites of the red marine alga *Delisea Pulchra,* belong to a class of natural compounds that exhibit strong bacteriostatic properties by interfering with the quorum sensing mechanism of bacteria which so far has not resulted in bacterial resistance. Serrulatanes are novel compounds extracted and identified from traditional Australian medicinal plants and belong to the diterpenes. Both natural compounds have shown promising levels of antibacterial activity against a range of gram positive bacteria – including methicillin resistant *S. aureus* - at low minimum inhibitory concentrations, and they have shown antibiofilm activity. Results will reveal the advantage and disadvantage of certain immobilization schemes combined with compounds. All results will be discussed and put in context to the cytotoxicity values of the corresponding pharmaceuticals.

Poster: 174
#762

Comparison of Drain Clamp After Bilateral T.K.A

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Suction drains provide an easy and feasible method for controlling hemorrhage after total knee arthroplasty. However, there has been no compromise regarding the optimal clamping time for these drains. We conducted a randomized clinical trial to compare 12-hour drain clamping and continuous drainage after total knee arthroplasty in terms of wound complications, blood loss and articular range of motion. In order to eliminate any other factor except duration of clamping, we chose to compare knees belonging to one single person, as well as restricting the study to those knees undergoing surgery due to osteoarthritis. From a total of 100 knees (50 patients) studied, the 12-hour clamping method resulted in a significantly smaller amount of post-operative blood loss ($p<0.001$). The passive ranges of motion and wound complications were not significantly different between the two groups.

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#765

Femoral Fixations in Anterior Cruciate Ligament Reconstraction: Comparsion Between Three Different Fixation Techniqes

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Background: The anterior cruciate ligament is the primary structure that controls anterior displacement in the unloaded knee. Anterior cruciate ligament reconstruction may return normal functions of the knee. The aim of the present study was to compare three different femoral fixation techniques in anterior cruciate ligament reconstruction. Methods: In a clinical trial study 120 patients that were candidates for ACL reconstraution were randomly divided into 3 groups of 40 individuals. The femoral fixations were by the three methods of "Aperfix" "Rigidfix" or "Endobutton". The cases were re-examined 12 months after surgery and evaluated by Lysholm score as well as with KT-1000 machine. The results were compered together for the three above methods. Results: The Lysholm score showed improvement from pre-operative values in all three techniques: From 63.21±18.59 to 90.64±9.47 in "Endobutton" group from 65.72±18.74 to 96.22±5.35 in "Aperfix" and from 69.21±17.45 to 90.64±9.47 in the "Rigifix" group. There were 6 failures in "Endobutton" 4 in "Rigidfix" and one in "Aperfix" group. The anterior displacement tibia was 3.96±1.58 millimeters in "Endobutton" 4.28±1.48 in "Rigidfix" and 4.03±1.79 millimeters in "Aperfix" group. There was no significant difference in the operating time in the 3 groups. Conclusion: Regarding the instant stability of the graft the "Aperfix" method seemed stranger. Further investigations with larger number of cases and longer duration of follow up are recommended.

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#757

Comparison Between Two-Dimensional (2D) and Three-Dimensional (3D) Planning in Total Knee Arthroplasty (TKA)

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Introduction:

Good alignment of mechanical axis of the leg is essential for the success in total knee arthroplasty (TKA). Precise pre-operative planning is one of the methods to reduce the malalignment after TKA using traditional mechanical guides. Femoral valgus angle was formed between mechanical axis and anatomical axis of the femur, and used as the reference angle to cut the distal femur during surgery. Condylar twist angle was defined as the angle between the clinical epicondylar axis and the posterior condylar axis. This angle was used as the reference angle to define the rotational alignment of femoral component with measured resection technique during operation. We compared the planning of these two reference angles with three-dimensional (3D) method and that with two-dimensional (2D) method.

Methods:

One hundred twenty knee joints underwent TKA were used in this study. Before surgery, long leg X-ray and computed tomography (CT) including femoral head and knee joint were performed in each case. In 2D method, the femoral valgus angles were measured using long leg X-ray firms, and the condylar twist angles were measured using axial CT images of distal femur. In 3D methods, we used digital imaging and communication in medicine (DICOM) formatted CT images and used 3D TKA planning software. Using software, we defined the plane containing femoral head center and transepicondylar axis as reference plane, made reconstructive planes and measure reference angles.

Results:

The average of femoral valgus angles in 2D and 3D method were 6.7 and 6.5, respectively. There are no statistical differences in both methods, but the error exceeded 1.0 degree was existed in 27%. The average condylar twist angles in both methods also did not differ (5.6 and 5.7), but more than half cases (63%) had errors over 1 degree.

Discussion and conclusion:

Limb positioning at the time of radiographic assessment alter the apparent alignment indices as previously described by other authors. There were no significant differences between 2D method and 3D method in this study. We thought this result was attributed to our confirmation of the patient's position when radiographic assessments were performed to reduce measurement errors in 2D method. On the other hand, the potential error over 1 degree existed in many cases in 2D methods. In 3D method, anatomical landmarks such as femoral head and knee center were placed without the harmful effect of limb positioning, and reference angles in TKA were measured accurately.

Poster: 177
#873

Laser Additive Manufactured Ti6Al4V Emi-Pelvis Custom Implant

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Reconstruction of the hemi-pelvis after resection for primary bone tumor is often challenging. For resections which involve removal of most of the hemi-pelvis including the acetabulum, there may be little or no bone left for reconstruction. Solutions include either no reconstruction, or the use of allograft, irradiation and re-implantation of bone, implantation of a socket into the side of the sacrum, or other innovations including rotation of the proximal femur to the sacrum and replacement of the proximal femur with a standard endoprosthesis.

Digital technologies now allow the manufacture of implants with a high degree of accuracy using data derived from CT scans and permit more accurate resection of bone using surgical navigation. The convergence of the additive manufacturing and surgical navigation technologies has opened up new possibilities for the reconstruction of bone defects.

The layered manufactured process has the advantage of design freedom, permitting the manufacturing of geometries and surface topographies not possible with traditional methods. This process leads to the manufacturing of a Ti6Al4V alloy implant which has mechanical performances that meet applicable standards (ASTM and ISO) for implantable materials. Where implants are in contact with bone, the technique allows the creation of hollow lattices which have been shown to encourage bone ingrowth and enhance fixation in animal models and which we have shown can be adequately sterilized.

We describe a case in which resection of almost the entire hemi-pelvis was facilitated by surgical navigation and the defect reconstructed using an implant made using a new additive manufacturing technique (fig 1). Fixation of the implant to the sacrum has been encouraged with an HA coated porous ingrowth lattice surface. Navigation techniques facilitated the passage of a fixation bolt through the bony sacrum (fig. 2). Although the follow up is short, this is a promising technique for the treatment of patients with these challenging bone defects.

Figures

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Figure 3 HYPERLINK "http://app.istaonline.org/figures/1632.jpg" \t "_blank"

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Figure 4

Poster: 178
#438

Relationship Between PF-Pressure and Rotational Alignment of Femoral Component in TKA

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Purpose:

Patello-femoral (PF) joint problem causes restriction of ROM and anterior knee pain. It has been reported that most common cause of pain after TKA arises from PF joint. Appropriate rotational alignment of the femoral component is an important factor for achieving suitable tracking of the patella and adequate ligament balance in TKA. The objective of the present study is to evaluate the relationship between PF-pressure and rotational alignment of femoral component.

Materials & Methods:

Good flexion and extension balanced 40 TKAs (P.F.C. Sigma RP-F, DePuy, USA) using parallel cut technique under CT based navigation (Vector Vision, Brain LAB, Germany) were evaluated. In this technique, tibial cut is performed first. Tibial cut surface is perpendicular to tibial shaft axis. Then, femoral rotation is set parallel to tibial cut surface. Flexion gap difference between medial and lateral was set within 2mm using CAS ligament tensioner (Depuy). Extension gap difference between medial and lateral was set within 2mm using Modular MIS ligament tensioner (Smith & Nephew). The force exerted on the patellar component was measured directly using ultra thin (100um) force transducer during surgery according to our previous report (J Arthroplasty 2010). Femoral component rotation was measured using spracondylar view (Kanekasu 2005) postoperatively.

Results:

Significant reverse correlation exists between external rotation of femoral component and PF contact pressure. The results showed that the more femoral component externally rotates the less PF contact pressure (Fig. 1). Rotational alignment of femoral component is 2.3 +/- 2 degrees external rotated from surgical epicondylar axis (SEA) in 70% of the cases.

Discussion and Conclusion:

These results may suggest that if surgeons use measured resection technique, reference axis for femoral component rotation may be clinical epicondylar axis than SEA, because more rectangular gap and lower PF pressure can achieved. Limitation of the present study is the clinical result is short term. We need to evaluate the correlation of PF pressure and long term clinical result in future.

Figures

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Figure 1

Poster: 179
#430

Fracture of Metallic Components in Cemented Unicompartimental Knee Arthroplasty: a 10 Years Experience

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Introduction:

Unicompartimental knee replacement represents a viable option in the treatment of knee arthritis in correct indications. Different modes of failures have been reported in literature. The most common are component

loosening, poor patients selection, poor surgical technique, polyethylene wear and progression of the arthritis to the other compartments. The purpose is to present the largest series in literature of metal components atraumatic fracture treated in a single orthopaedic center.

Materials and Methods:

Since 1999 among an experience of 109 unicompartimental knee arthroplasty failures referred to our center, the Author presented 6 cases of metal components atraumatic fractures in cemented UKRs, 4 in the femur and 2 in the tibia leading all to an implant revision. All femoral fracture occurred within 3 years from implantation, tibial fractures occurred at mean of 12 years, 3 patients were males and 3 females. Mean BMI was to 32.4 (range 28-35).

Results:

All the revision procedures were performed under computer assisted guidance. Intra operatively we did not registered any complication. According to Anderson Orthopaedic Research Institute Bone Defect Classification, all the femoral component fractures were graded as grade I and tibial fractures as grade II. All our femoral cases were referred to us before 2003 always regarding older designs and with same fracture localizations closer to a femoral pegs All femoral fractures were revised using primary cruciate retaining total knee arthroplasties while in tibial cases always using posterior stabilized implants and both wedge and stem in one case. The mean surgical time was 104.3 minutes (range: 85-132) and the mean hospital staying was 6.9 days (range: 5-9 days). At the latest follow-up the mean Knee Society Score was 80.04 (range: 74-88), the mean Functional score was 82.3 (range: 70-100)

Discussion:

Fracture of metallic components is an uncommon complication in UKR, according to our experience it occurs with different causes and in different phases depending on the side. Femoral fracture occurred as an early complication with minimal bone loss and easier revision. It has different localization according to the design of the shield but always close to a femoral peg. We supposed this is mainly caused by oldest weaker designs. Tibial component fractures occurred as a long term follow-up complication, it involves the posterior half of the component, associated to bone loss and metallosis which require more demanding revision procedure. It is recommended periodical follow-up of UKR patient especially in higher BMI patients.

Poster: 180
#998

Study of Antimicrobial Effects and Adherence of Nitinol: A Comparison Between Thin Film and Bulk Form

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Abstract

Background & objective:

Nickel – Titanium (NiTi) with a molar composition of 50:50 or nitinol alloy exhibit special mechanical properties. These properties can be put to excellent use in various biomedical applications including: intravascular stents, orthodontic wires, prosthetic heart valves, angioplastic guides, orthopaedic implants, bone substitution materials, endoscopic instruments, implant stents and filters. The adhesiveness of nitinol for microorganisms may be decreased by oxidizing agents and surface heat treatment. In the present study, we investigated the rate of adhesiveness and cytotoxicity of alloy for microorganisms, and these properties, compared in thin film and bulk form.

Material & Methods:

In this analytical comparative study, small parts of thin film and bulk form of nitinol (15mm15mm) were selected

and sterilized in autoclave (15 Ib for 20min). Five microorganisms 4 bacteria (*Escherichia coli*, *staphylococcus aureus*, *Pseudomonas aeruginosa*, *Bacillus cereus*) and 1 yeast (Candida albicans) have been examined. The alloy samples (thin film and bulk form of nitinol) and suspensions of every microorganism were incubated in culture flasks for 24h at 37. Every suspension of microorganism was counted before and after examination.

Results:

The less decreasing rate of microbial cells have been detected in thin film in comparison with bulk form (39% for thin film Vs, 62% for bulk form, $P<0.05$). In the examination of thin film , decreasing rate of 14% for *E. Coli*, 44% for *P. aeruginosa*, 30.1% for S.aureus. 22% for *B.cereus* and 6.4% for *Candida albicans* were registered. In the examination of bulk form, decreasing rate of 39% for *E.coli*, 62% for *P. aeruginosa*, 61.9% for *S. aureus*, 49% for *B. cereus* and 31% for *C. albicans*

Discussion & Conclusions:

In this study, in examination of every forms of nitinol alloy, decreasing rate of microbial population were detected. At the end of the test, less decreasing rate of the cells was seen in the thin film of the nitinol. This may be due to less cytotoxicity and nickel release of thin film for bacterial and fungal cells in comparison with the bulk form. As it appears in electron microscopy, less adhesiveness of thin film can be attributed to smoothness,These different behaviors of the two forms of nitinol alloys is probably due to the better biocompatibility of the thin film. This new form of the nitinol ally can be a better promising material for developing medical prosthetic devices.

Poster: 181
#464

DXA Measurement of Bone Mineral Density Around the Cemented Exeter Universal Stem: A Prospective Study in 30 Patients With 2 Years Follow-Up

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Introduction:

Total hip arthroplasty (THA) changes the loading pattern in the proximal femur. Two well-documented changes in the bone of the proximal femur after THA are distal cortical hypertrophy and resorption of the medial femoral neck, so called calcar resorption. We quantified the changes in bone mineral density (BMD) for 2 years after insertion of the cemented Exeter Universal stem.

Patients and Methods:

We studied 30 patients who had a THA with the cemented Exeter Universal stem. There were 2 men and 28 women with a mean age of 64.5 years (41 to 85). The primary diagnosis was osteoarthritis in all cases. No patient was being treated with bisphosphonate, vitamin D, systemic estrogen, or systemic glucocorticoids. The operations were performed through posterior approach without the use of a trochanteric osteotomy. The femoral implant was the collarless, polished, double tapered stem. Cementation was done using Simplex cement and third-generation cementation techniques. They were allowed full weigh bearing from the first postoperative day. There were no postoperative complications. All had a well-functioning arthroplasty at follow-up. BMD was measured at postoperative 2 weeks (baseline) and 3, 6 12, 18, 24 months using dual-energy X-ray absorptiometry (DXA) on lumbar spine and proximal femur. On the proximal femur, stem, cement mantle, bone and soft tissue were all in the field of scan. The periprosthetic bone was subdivided into 7 regions of interest according to Gruen. Wilcoxon matched-pairs signed-rank test was used in the statistical analysis. Differences were considered significant at p-value less than 0.05.

Results:

During the first 3 months, a significant decrease in BMD was seen in both lumbar spine and periprosthetic bone in all zones. The range of reduction in periprosthetic BMD at 3 months was between 6.1% and 11.5% compared to baseline. At 12 months in zone 1 there was a significant increase in BMD compared to that at 3 months, and there was no significant difference compared to baseline. At 24 months in all zones except 1, periprosthetic BMD remained lower than baseline with no significant difference compared to those at 3 months.

Interpretation:

Our study showed a pattern of early periprosthetic remodeling of bone after cemented THA with collarless, polished, double tapered stem. The periprosthetic BMD decreased after surgery. In lateral side of trochanteric

region, BMD had increased again until one year postoperatively. In other periprosthetic regions, BMD had decreased and remained lower than baseline at postoperative 2 years.

Poster: 182
#1114

Intra-Operative Soft Tissue Balance Reflects Minimum 5-Year Mid-Term Outcomes in Cruciate-Retaining and Posterior-Stabilized Total Knee Arthroplasty

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Backgrounds:

In order to permit soft tissue balance under more physiological conditions during total knee arthroplasties (TKAs), we developed an offset type tensor to obtain soft tissue balancing throughout the range of motion with reduced patella-femoral (PF) and aligned tibiofemoral joints. However, the clinical relevancy of intra-operative soft tissue balance measurements on post-operative outcome is unclear. The main purpose of the present study was to assess the correlations between intra-operative soft tissue balance measurements using the tensor and the 5-year mid-term post-operative values assessed by stress radiographs in both cruciate-retaining (CR) and posterior-stabilized (PS) TKAs. Secondary, we tried to compare the clinical outcomes of CR and PS TKAs at a minimum 5-year follow-up.

Methods:

The use of the tensor for TKAs aims to assist soft tissue balancing throughout the full range of motion. With a reduced PF joint and femoral component in place, we measured intra-operative soft tissue balance including the joint component gap and ligament balance at 0, 10, 45, 90 and 135° of flexion in 41 varus type osteoarthritic patients (19 CR TKA, 22 PS TKA), and assessed the correlations between the intra-operative values and the post-operative values assessed by stress radiographs at extension and flexion at a minimum 5-year follow-up. At the 5-year follow up, clinical outcomes including range of motion and Knee Society Clinical Rating System were also compared between the two types of TKAs.

Results:

In CR TKAs, the post-operative soft tissue balances at both angles were significantly correlated with the intra-operative values. In PS TKAs, the post-operative soft tissue balances at extension, not flexion, were significantly correlated with the intra-operative values. However, there were no statistical differences in clinical outcomes between the two groups.

Conclusions:

The intra-operative condition of the soft tissue balance reflected the post-operative values especially in CR TKAs even at 5-year mid-term follow-ups. However, the differences in intra-operative soft tissue balance between the two groups did not influence post-operative clinical outcomes.

Poster: 183
#1019

Static and Dynamic Mechanical Behavior of a New Vitamin E Stabilized UHMWPE and Gamma Irradiated

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INTRODUCTION

A new medical homopolymer UHMWPE resin with a high degree of linearity and stabilized by blending with

trace concentrations of a-tocopherol has been very recently introduced for total joint arthroplasty components. The design of new components for total hip and knee replacements based on this and other novel materials requires good understanding not only of their static mechanical properties, but also of their viscoelastic behavior. On the other hand, radiation crosslinking and terminal sterilization have become essential processes to achieve wear resistance and biological inertness of UHMWPE components [1]. Therefore, the purpose of this work was to study the influence of gamma irradiation on the static and dynamic mechanical behavior of this new material.

MATERIALS AND METHODS

The medical resin (Homopolymer MG003) with 0.1 % vitamin E was kindly supplied by DSM Biomedical, The Nederlands. Specimens were prepared for further gamma irradiation in air to a final dose of 100 kGy (Aragogamma, Barcelona, Spain), which were denoted MG003-I. Mechanical properties were characterized by uniaxial tensile test (ASTM D638), impact test (ASTM F648), essential work of fracture, J-integral (D6068-02) and dynamic mechanical thermal analysis (DMTA model MKII of Polymer Laboratories). Fractographic study was conducted on the fracture surfaces of tensile specimens using a SEM (Jeol, JSM-6400).

RESULTS AND DISCUSSION

Preliminary thermal characterization confirmed MG003 featured 61 % crystallinity content and a melting transition temperature, T_m= 139.7 ± 1.0 ºC. Irradiation increased both parameters up to 63.3±1.7 and 143.3 ±1.8 ºC, respectively. The stress-strain curves for the as-received and irradiated MG003 materials followed the typical behavior of UHMWPE materials. The obtained mechanical parameters are shown in Table 1. After uniaxial tension to failure, the fracture surfaces corresponding to MG003 specimens revealed three different regions: initial flaw, a critical crack region (CCR) and a fast fracture region (FFR). Gamma irradiation introduced some changes in fracture surfaces, specially a loss of the regular structure in CCR. Toughness parameters obtained with different techniques for all materials are reflected also in Table 1. DMTA results showed that two relaxations g and a were presented in the temperature dependence of the storage modulus, E´´, and the loss tangent, tag d (Figure 1). The first relaxation is attributed to the amorphous region and the second one to crystalline regions. No significant differences were found between the as-received and the gamma irradiated MG003 polymers.

The present mechanical findings confirmed the elevated yield stress of MG003 resins, in agreement with their high crystalline content, which in turn stems from its high degree of linearity. Upon gamma-irradiation in air, MG003 experienced crystallinity and T_m increases, similar to those registered for conventional GUR resins. One of the most important differences between this new MG003 and GUR resins is the toughness behavior. Typically, GUR UHMWPE materials experience a toughness decrease associated to the elevated crosslinked densities imparted by gamma or e-beam irradiation [2]. In contrast, MG003 experienced lower or even no reduction in its toughness performance upon irradiation. Since the amount of vitamin E in MG003 is too small to negatively impact the crosslinking efficiency, another mechanism must control the toughness behavior of this polymer.

REFERENCES

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Figures

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Figure 2

Poster: 184

#445

BMD Change Under Bisphosphonate Therapy -Comparison Between Mobile and Fixed Bearing TKA Prostheses-

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Introduction:

Bone mineral density (BMD) around prosthesis decreases about 20% after TKA because of stress shielding. Previous DEXA study revealed that bisphosphonate therapy and mobile bearing prosthesis (Minoda and Kobayashi, JBJS Am 2010) prevent stress shielding. The purpose of this study was to compare the BMD between mobile and fixed bearing PS prosthesis under the bisphosphonate therapy.

Methods:

33 knees receiving fixed bearing PS prosthesis and 29 knees receiving mobile bearing PS prosthesis had dual energy x-ray absorptiometry (DEXA) scans at preoperatively and 6 and 12months post-operatively. All the patients were treated with bisphosphonate (Alendronate 35mg/week) during the follow up period.

Results:

The difference of BMD change around the femoral component (-7 to -12% in fixed bearing group and -3 to -11% in mobile bearing group) or the tibial component (-14 to 5% in fixed bearing group and -12 to 1% in mobile bearing group) was not statistically significant between the groups.

Discussion:

Mobile bearing PS prosthesis did not reduce postoperative BMD decrease, comparing to fixed baring PS prosthesis. However, the decrease of BMD in our both groups was less than that in previous reports without bisphosphonate therapy. Bisphosphonate might offset the effect of mobile bearing mechanism.

Conclusion:

Mobile bearing prosthesis did not reduce postoperative BMD decrease comparing to fixed baring prosthesis. Bisphosphonate therapy might offset the effect of mobile bearing mechanism on BMD change.

Poster: 185
#741

Early Head-Neck Junction Failure in Asian Version Metal-on-Metal THA

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Case:

A 66 year old female with osteoarthritis was undergone bilateral THA using AML-A plus (Asian version stem with 9/10 taper) stem and 36mm Ultamet metal-on-metal system produced by DePuy company. Clinical outcome in the first year was excellent. After two years, she had severe left inguinal pain and active leg raising was impossible. MRI and ultrasonic examination showed fluid collection in the Iliopsoas muscle sheath. Low grade CRP elevation was observed, but she had no elevation in WBC count. Bacterial culture of aspirated fluid was negative. Serum chromium level was elevated to 1.39mmg/dl. Metal allergy was suspected and liner exchange in left hip was done. Intraoperatively, dark serous fluid was observed from the joint and the sheath of Iliopsoas muscle. We found black material attached firmly on the base of the ball head. Stripes on the neck and head junction were deformed and collapsed. Histopathological diagnosis was chronic necrotizing fibrous synovitis and arthritis with metal allergy. Metal debris was suspected to be generated from this area. Highly crosslinked polyethylene liner and 32mm metal ball head was placed and her complaint was gone for a while. Unfortunately, after 1year, another side inguinal pain occurred, and liner exchange operation was performed on the right hip again.

Discussion:

Some Asian version prosthesis has reduced neck. Although this is favorable for Asian style activity which need

good ROM in smaller patients, this may result in mechanical fragileness. Large head metal on metal joint surface may cause excessive torque force on the head-neck junction in some situation. Asian surgeons should be aware that Asian version prosthesis may have fragileness and can cause unexpected trouble.

Poster: 186
#506

Investigation of the Effect of Drugs to Prevent VTE After Primary THA

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INTRODUCTION

In these days, antithrombotic drugs such as fondaparinux and enoxaparin have been used to prevent the venous thromboemborism (VTE) after the orthopaedic surgery in Japan. In the current study, we investigated the differences between fondaparinux and enoxaparin about the incidence of VTE, complications, and plasma biochemical data after the primary total hip arthroplasty (THA).

PATIENTS

We studied 238 hips of 222 patients. They were treated for primary total hip arthroplasty (THA) between May 2006 and October 2010. All hips were operated in Okayama University Hospital. Patients who received the antithrombotic therapy before the surgery were excluded from this study. We devided them into 3 groups. Group A had 60 hips operated between May 2006 and July 2007. They didn't receive antithrombotic drugs. Group B had 89 hips operated between July 2007 and December 2008. They received the fondaparinux sodium subcutaneously. Group C had 89 hips operated between December 2008 and October 2010. They received the enoxaparin sodium subcutaneously.

METHODS

We used antithrombotic drugs for the patients of group B and C from days 2 to 10 postoperatively. Antithrombotic drugs were started from 2 days after the surgery because we used the continuous epidural anesthesia for 2 days. All patients were investigated about the incidence of VTE by the contrast enhanced CT after 7 days postoperatively.

RESULTS

VTE were recorded in 10 (17%) of 60 patients on group A, in 8 (9%) of 89 patients on group B, and in 6 (7%) of 89 patients on group C. There was no major bleeding in every group. However, we stopped antithrombotic drugs for 2 patients of group B and 1 patient of group C because of minor bleeding. About the plasma biological data, hepatic enzymes were elevated irregularly in 10 patients of group B and 12 patients of group C. The levels of D-dimer on group B and group C were lower than those of group A.

CONCLUSIONS

In the current study, the use of antithrombotic drugs significantly reduced the incidence of VTE after primary THA. Enoxaparin was effective for the prevention of VTE after primary THA. Though the plasma D-dimer level is one of the screenings for VTE, the cutoff value was not available for the patients in the antithrombotic therapy. The contrast enhanced CT is the most useful screening method for the patients after primary THA to investigate no symptomatic VTE.

Poster: 187
#584

Estimation of Hospital Length of Stay for Total Knee Arthroplasty

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Introduction:

The purpose of this study was to verify the discharge criteria to estimate the appropriate length of hospital stay before surgery. We focused on determining the most influential variable on the length of hospital stay after a total knee arthroplasty (TKA).

Materials and Methods:

The subjects for this study were patients who have had TKA surgery at Anshin Clinic between November 2009 and July 2010. 70 women's knees (mean age of 74.6year old; from 58 to 85) and 13 men's knees (mean age of 73.54; from 62 to 83), the total of 83 knees, were the subject of this study. The mean length of hospital stay within the subjects was 10.48 days, from 7 to 23 days. As discharge criteria, sex, age, BMI, the previous experience in TKA surgery for the opposite knee, family support, complication of other illness, walking ability before surgery, knowing and understanding of the TKA operation, requesting for longer hospital stay, and residential environment, were scaled in numeral numbers, and evaluated. Using these criteria as independent variables, we examined the regression model focusing on the length of hospital stay as dependent variable. SPSS was used for statistic software.

Results

The independent variables that were statistically significant were the request for long hospital stay, understanding of operation, and the ability to walk before surgery. The other variables did not show notable significance.

Discussion

Unlike our expectation, the ability to walk before surgery was not the most significant factor to be influencing on the length of stay. As a result, the patients' expectation for hospital stay and the understanding of the operation was the most influential as discharge criteria. Therefore, providing enough information to educate the patients is important for the appropriate hospital length of stay.

Poster: 188
#638

Association and Impact of Patellofemoral Dysplasia on Patellofemoral Arthropathy and Arthroplasty.

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Background:

Petellofemoral arthritis is a common condition in the middle aged and elderly population. Association of this disease with patellofemoral instability is known. Dysplasia may complicate patellofemoral arthroplasty. The aim of this study was to examine the association of patellofemoral dysplasia in presence of patellofemoral arthritis.

Methods:

Eighteen consecutive patients who underwent robotic image based patellofemoral arthroplasty were compared with an age and sex matched group of patients who underwent medial unicompartmental arthroplasty using the same image based navigated system and had no patellofemoral or lateral disease or mal-alignment.
The compared parameters were patellofemoral trochlear angle and Dejour score in the preoperative radiographs and patellofemoral trochlear angle and internal rotation of trochlea as compared to intercondylar line in the proximal, the middle and distal trochlea.

Results:

We found significantly higher rate of patella alta (T=5, P=0.0001) and trochlear dysplasia (6% vs. 55%) as manifested by increased in the trochlear angle and Dejour score. Furthermore trochlea was found to be grossly internally rotated in patellofemoral arthritis and mildly internally rotated in the control group.
In conclusion, patellofemoral indicators of instability are present in association with idiopathic patellofemoral arthritis. This dysplasia is associated with higher rate of trochlear internal rotation. Correction of this internal

rotation is essential in the success of arthroplasty in patients with patellofemoral disease.

Poster: 189
#701

Metallic Post Traumatic Radial Head Replacement

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Background:

Radial head fractures represent about one third of all adult elbow fractures. These injuries are commonly described as per Mason-Johnson classification (Figure1). Internal fixation should be reserved for minimally comminuted fractures, while un-reconstructable configurations could be treated with radial head replacement. This report presents the results of using Liverpool Radial Head (LRH) replacements for these fractures.

Methods:

Thirty-two patients (15 males and 17 females) were treated with metallic radial head (LRH) replacements. 29 cases were treated following primary post-traumatic un-reconstructable radial head fractures and 3 cases after failed open reduction and internal fixation (ORIF). Patients were followed up using Liverpool Elbow Score (LES) which is scored between 0-10 with 10 indicating the best outcome. The average follow-up period was 4.5 years (range: 2-7 years).

Results:

Average LES for the whole group was 8.0 while for those who were treated after failed ORIF was 7.9. The LES was significantly higher for radial head fractures classified pre-operatively as Type III compared to Type IV fractures ($p = 0.02$). Furthermore, replacements on the left side had a better outcome than those on the right side ($p = 0.003$). However, there was no difference in the outcome in terms of age or gender.

Conclusion:

The results showed a good outcome for post traumatic Liverpool Radial Head replacement as measured by the LES. Hence, this prosthesis provides an effective treatment for this type of un-reconstructable radial head fractures.

Figures

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Figure 5

Poster: 190
#892

The Effect of Traditional vs. Single Use Instrumentation on or Efficiency, Contamination, and Costs in Primary TKA

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Summary:

Single use instruments show increased OR efficiency and may lower costs in primary TKA compared to traditional instrumentation.

Introduction:

As healthcare evolves, innovation is helping to improve patient outcomes and operating room efficiency. The purpose of this study was to determine the effect of traditional instrumentation vs. single-use instrumentation (SUI) on OR efficiency, contamination, and economic outcomes in non-navigated and navigated TKA procedures.

Methods:

This multi-center prospective controlled trial was conducted by eight surgeons at six sites. Patients were split into four groups: Group 1 (Non-navigated Traditional (n=96), Group 2 (Navigated traditional (n=97)), Group 3 (Non-navigated SUI (n=95)), and Group 4 (Navigated SUI (n=100)). Efficiency was examined by measuring specific time intervals based on milestones in the OR preparation, surgical procedure, and OR cleanup. Instrumentation contamination was determined by counting the number of tray sterility indicators, pans, and instruments that were compromised. Cost measurements were based on the number of instrument trays sent to central sterile supply and the time required to re-wrap trays during processing.

Results:

Sites were significantly more efficient with SUI than with traditional instruments. Combined instrument setup and cleanup time was reduced by six minutes in non-navigated (p=0.000) and eight minutes in navigated (p=0.042) using SUI. Surgical episode time was reduced by three minutes in non-navigated (p=0.100) and nine in navigated (p=0.000) minute reductions using SUI. Notably, there was a decrease in potential contamination in 59% (non-navigated) and 32% (navigated) with fewer compromises of tray sterility indicators, pans, and instruments in the SUI group vs. traditional. Reprocessing costs were lowered by an estimated $75 to $330 per surgery due to reduced trays and wrapping time.

Conclusion:

Single-use instruments show promising benefits, but further patient follow-up is needed to confirm safety and efficacy before they can be widely recommended.

Poster: 191
#710

Short-Term Follow-Up of Posterior Cruciate LigamentSacrificed Total Knee Arthroplasty Using a Mobile Polyethylene Insert. - Navigation-Aided Technique -

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Objective:

Recently, mobile ultracongruent polyethylene insert is used to increase joint stability in PCL-sacrificed TKRA with non-posted mobile bearing. However, as yet there has been no report regarding this implant. In this study, the clinical and radiological results of surgery using that implant were analyzed through a navigation system.

Subjects and Methods:

The subjects were 107 cases of the 79 patients to whom the rotating tibial implant, E-motion® UC type (Aesculap, Tuttlingen, Germany), was applied after posterior cruciate ligament resection among the patients who underwent total knee arthroplasty from September 2006 to December 2008. The subjects included one male and 78 female patients, and the average age was 68 years old, ranging from 58 to 81. The follow-up duration was at least 24 months, and 40 months on average. The preoperative diagnosis was osteoarthritis in all cases. The operation was performed by one surgeon for all the subjects using a navigation system. Patella resurfacing was not carried out in all the operations. For the clinical evaluation, the knee score and the functional scores were measured preoperatively and at the time of final follow-up. With reference to a 5 mm joint line change measurement recorded by the navigation system, which can affect the clinical result, the comparison and evaluation were performed by dividing the subjects into Group I (≤5 mm) and Group II (>5 mm). Radiological evaluation was performed by measuring the angle of the mechanical axis of the lower extremities and the patella tilting angle preoperatively and

at the time of final follow-up using plain radiographs.

Results:

Seventy-nine subjects (107 cases) were followed up for 24 months (or more 40months on average). According to the clinical result, the mean KSS knee score improved from a preoperative score of 40.9 to a final follow-up score of 83.3 ($p<0.0001$). In addition, the mean functional score improved from a preoperative score of 49.3 to a final follow-up score of 86.4 ($p<0.0001$). Finally, the mean joint line change ((thickness of the polyethylene implant)-(resection thickness of lateral tibial condyle)), which can affect the clinical result, was 5.82 mm, ranging from -1 to 12 mm. The clinical and radiological evaluations were performed by dividing the subjects into two groups in relation to the reference value of 5 mm, but no significant difference was found. The mechanical axis angles of the lower extremities improved from the preoperative value of varus 11.0° to the final follow-up value of varus 2.2°, and the difference was significant ($p<0.0001$). The mean patella tilting angles were 8.1° and 6.5°, respectively, at the time before the operation and after the final follow-up; this difference was not significant ($p=0.89$). At the time of the final follow-up, there had been one case of dislocation of polyethylene insert where femoral avulsion fracture took place in the medial collateral ligament. The two-stage revision TKRA was carried out because of the complication of infection following the medial collateral ligament reconstruction in this case.

Conclusion:

Good clinical and radiological results were found after at least two years of follow-up subsequent to total knee arthroplasty, in which a rotating ultracongruent polyethylene insert was applied after posterior cruciate ligament resection using a navigation system.

Poster: 192
#825

Surgical Site Infection Rates in Total Knee Arthroplasty Comparing Traditional vs. Single Use Instrumentation

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Summary:

Single-use instruments are being explored as an alternative to reusable instruments. Adoption will only occur if there is no increase in infections with a neutral or positive impact on hospital costs.

Introduction:

SSI's are a significant and common complication in TKA. Historical controls state that infections cost a hospital a mean of $25,546±$39,875 (Range: $1783-$134,602).[1] The purpose of this study was to evaluate if traditional vs. single-use instrumentation had an effect on SSI's.

Methods:

A retrospective study was performed comparing 90-day peri-operative SSI rates of TKA's performed by a single surgeon at a large community hospital comparing single-use and traditional TKA instrumentation trays. The surgeon performed TKA using a similar non-navigated procedure, staff, and operating setting for both groups. The groups received similar post-operative care management.

Results:

Between Jan 2005 and Feb 2011, the primary surgeon performed 169 traditional and 167 single-use instrumentation TKA's. The groups were similar in demographics (age, gender, height, weight) and operative time ($p=0.09$). SSI's for the traditional group (n=5) compared to single-use group (n= 0). The SSI from the traditional group could potentially cost the hospital a mean of $127,730.

Conclusion:

Single use instrumentation holds promise in the impact of hospital costs while providing reliable patient care. Patients in the single-use group had 0% infections compared to the traditional (2.95%). Impact of reprocessing of reusable instruments must be considered to the total cost of episode of care. A larger prospective-randomized trial

is warranted.

Reference:

1. Stone PW et al. Systematic review of economic analyses of health care-associated infections. Am J Infect. Cont. 2005; Nov;33(9):501-9.

Poster: 193
#631

Total Hip Arthroplasty in Patients With Deep Brain Stimulation for Parkinson's Disease

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Deep Brain Stimulation (DBS) is a surgical procedure to implant a neurostimulator delivering electrical stimulation to the target area of the brain, such as thalamus, subthalamic nucleus and globus pallidus to control abnormal nerve signals that cause symptoms of Parkinson's disease (PD). This treatment is used for PD patients whose symptoms don't respond to drug treatments.

PD patients can develop subluxation or osteoarthritis of the hip because of imbalanced and poor muscle tone, spasticity or rigidity. Additionally, they easily fall due to the walking difficulty and are high risk group against hip fracture. The need of surgical treatment is increasing, however, hip arthroplasty for PD patients is quite a challenge with the remarkable risk of loosening and dislocation. Nevertheless, the number of previous publication is limited. We would like to share and discuss our experiences over PD patients who undergone total hip arthroplasty with subthalamic nucleus (STN)-DBS.

Poster: 194
#469

Joint Distraction Force Affects Soft Tissue Balance Evaluation in Posterior Stabilized Total Knee Arthroplasty in Varus Type Osteoarthritic Knee

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Objective

The gap balancing technique has been advocated as an effective method for the soft tissue balance in TKA. Although both thickness and orientation of femoral bone cut rely on the intra-operative soft tissue balance evaluation, the biomechanical conditions were obscured during these evaluations.

The purpose of the present study is to analyze the influences of joint distraction force on the soft tissue balance evaluated with both conventional manner between osteotomized surfaces and physiological joint condition after femoral trial placed and patello-femoral (PF) joint reduced.

Materials and Methods

Fifty varus type osteoarthritic knees implanted with posterior stabilized (PS) TKAs were subjected to the intra-operative soft tissue balance measurement. All TKAs were performed using measured resection technique. Femoral rotation angle was preset at 3 or 5° according to the condylar twist angle measured with preoperative CT.

Following each bony resection and soft tissue releases, we measured soft tissue balance using a newly developed offset type tensor. The soft tissue balance measurements were performed at extension and flexion of the knee in both conventional manner (osteotomy gap) and proposed physiological condition (component gap) with femoral trial in place and PF joint reduced.

Soft tissue balance was evaluated by the center joint gap (mm) and ligament imbalance (°; positive in varus) applying different joint distraction forces at 20, 40 and 60 lbs (89, 178 and 267 N). Both joint gap and varus imbalance were compared among different joint distraction forces using ANOVA. $P<0.05$ was considered statistically significant.

Results

Joint center gap were significantly increased with increasing joint distraction force at knee extension and flexion in both joint conditions. Furthermore, varus ligament imbalances were also significantly increased with joint distraction force at both extension and flexion in both joint conditions.

Discussion and Conclusion

In the present study, both center join gap and varus ligament imbalance were significantly increased with the increase of joint distraction force during soft tissue balance evaluation in the joint condition before and after femoral trial component placement.

In the varus type osteoarthritic knee, medial soft tissue structures were pathologically contracted, and that of lateral side was elongated. And the structural properties of soft tissue envelops also might be different between medial and lateral compartment. The stiffness of the medial soft tissue might be higher than that of lateral. These differences in the structural properties between medial and lateral soft tissue would cause the increasing varus ligament imbalance with the increase of joint distraction force.

Although femoral rotation angle with gap technique was determined depending on the ligament imbalance at knee flexion, ligament imbalance was found to significantly change depending on the joint distraction force ranged from 20 to 60 lbs. This change might be a cause of incorrect osteotomy and unexpected post-operative flexion instability. We should aware of this biomechanical issue and carefully determine the femoral rotational osteotomy angle depending on not only soft tissue balance evaluation but also anatomical orientation such as AP axis and trans-epicondylar line.

Poster: 195
#528

A Comparative Micromotion Analysis of Two Cementless Hip Stems.

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Introduction:

Implantation of total hip arthroplasty (THA) may induce remodelling of the periprosthetic bone structure. Many implant-related parameters, like material and elasticity influence the remodelling processes. During the past years, there is a tendency to shorter hip stems to preserve femoral bone stock and to reduce the risk of proximal stress shielding.

After clinical introduction of the Fitmore® stem (Zimmer) we noticed the formation of cortical hyperthrophies in a significant amount of cases.

The aim of this biomechanical study was to analyse possible biomechanical reasons for the formation of these

distal hyperthrophies. Therefore we determined the primary stability, which has notable influence on long-term stability of the implant. We compared the Fitmore® stem to the well established CLS® stem (Zimmer).

Methods:

A standardized neck resection was preformed using eight synthetic femurs. Four Fitmore® and four CLS® stems were implanted. Micromotions of the stems and femurs were measured with a high precision measuring device at defined sites under two different cyclic load applications. An axial torque of +/-7Nm around the stem axis was applied to classify the rotational implant stability. In a second step a varus-valgus-torque of +/-3.5Nm was applied to analyse the bending-behaviour of the stem. Comparing the motions of the stem and femur at different sites allowed the calculation of relative micromotions at the bone-implant-interface.

Results:

The lowest relative micromotions were detected within the proximal part of the stems near the Trochanter minor (Fitmore® = 7.50mdeg/Nm and CLS® = 6.97mdeg/Nm). Maximum relative micromotions were found at the distal tip of the stem for both designs, in which the shorter Fitmore® stem showed lower relative micromotions (11.91mdeg/Nm) compared to the CLS® (16.12mdeg/Nm).

Regarding the medio-lateral bending behaviour, the CLS® stem followed the bending of the bone. Contrary to this, the Fitmore® stem acted rigidly, indicating less flexibility.

Discussion:

Both stems showed low micromotions within the proximal part of the stem. Under medio-lateral torque application, the CLS® stem followed the physiological bending of the bone, whereas the shorter Fitmore® stem seemed to act like a rigid body and tilted instead of bending. This may be due to an enlarged axial cross-section of the stem and therefore an enlarged implant stiffness of the Fitmore® compared to the CLS®. Such a tilting of the stem may induce high intra-femoral stresses which may possibly lead to cortical hypertrophies.

Poster: 196
#526

Fixation Behaviour of Modular Revision THA Stems in Vitro - Conical vs. Cylindrical

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Introduction:

Primary total hip arthroplasty results in good long-term success. In the case of a cementless revision with extensive loss of femoral bone stock there are different fixation principles. The aim of our study was to analyze and to compare the primary stability of modular revision hip stems, as a function of different stem design parameters and of different femoral defect situations in synthetic bones and human specimens.

Methods:

Eight synthetic femurs and 4 pairs of fresh-frozen femurs were included. In both subjects a standardized segmental AAOS type I defect was created. Four conical (MRP®, Peter Brehm GmbH) and four cylindrical (S-ROM®, DePuy Orthopaedics Inc.) revision hip stems were implanted with equally but randomly allocated side distribution each. Micromotions of stems and femurs were measured with a high precision measuring device at defined levels under a cyclic and axial torque application. In a second step the defect was expanded to an AAOS type III defect and subjects were remeasured. Comparing the micromotions of stem and femur at different levels allowed for the relative micromotions to be calculated. They served as indicators for the stem fixation and the primary stability respectively.

Results:

For a type I defect the lowest relative micromotions were located within the proximal and distal isthmus for both stems. For the conical stem the maximum relative micromotions were located at the proximal rim of segmental defect site. Contrary to that, maximum relative motions for the cylindrical stem were at the distal stem tip.

For the type III defect maximum motions were found to be at distal stem tip for the conical and at proximal rim of defect site for the cylindrical design. Compared to the femur with a type III defect, both stems were fixated more sufficiently concerned with a type I defect. Nevertheless no significant differences could be observed.

Discussion:

For both stems relative micromotions seems to be sufficient for a tight primary fixation regarding small segmental defects. As required in revision hip surgery, both stem designs are capable to generate the closest fitting within the proximal and distal isthmus in human specimens and synthetic bones. The conical design showed nevertheless higher micromotions. The expansion of femoral defect was accompanied with increased relative micromotions for both stems, whereas these motions were clearly increased for the cylindrical stem in comparison.

Both stems showed differences in relative micromotions and, therefore, for their fixation characteristics. A nearly similar increase of motions could be observed between a type I and type III defect for both stems. In conclusion small bone defects - e.g. the AAOS type I defect - could be well treated with conical and cylindrical revision stems as well. Moreover, conical stems might be preferable in the face of defects involving the isthmus - e.g. the AAOS type III defect.

Poster: 197
#405

Flexibility of the Implanted Knee Depends Mainly on the Patients and Partly on the Prostheses Designs

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INTRODUCTION

In this study, knee kinematics was assessed in the same patients with different PS TKA systems. The patients had Scorpio Superflex system (Stryker, USA) in one knee, and had Scorpio NRG system in the other. Superflex has a rectangular tibial post and longer posterior flanges of the femoral component, and NRG has a round tibial post and shortened posterior flanges. Our hypothesis was that knees with Superflex system would have smaller rotational flexibility due to the rectangular tibial post.

METHODS

This study consisted of 5 cases. The average age at this study was 74.4 years old. The average period from TKA to this study was 5.7 years with Superflex and was 4.8 years with NRG. The flexion angle was more than 135° in all knees. The knee society score was 100 in all knees.

The fluoroscopic images of the prostheses were taken during knee extension/flexion in all implanted knees. Then, a torque of about 5Nm was applied to the lower leg, and the varus/valgus flexibility and external/internal rotational flexibility were assessed at 0°, 45°, 90° and 120° flexion. For the evaluation of varus/valgus flexibility, a manual muscle tester was applied 20cm distal to the knee joint. For the evaluation of the rotational flexibility, a specially designed booth was attached, and torque-meter was used to apply the torque. The pattern matching method was used to measure the 3D movements of the prostheses from the fluoroscopic images.

RESULTS

The mean varus/valgus angle during flexion was less than 1°, and no difference was found between two groups. The tibia rotated about 10° during flexion even with Superflex. No significant difference was found in the varus/valgus flexibility, or in the rotational flexibility. Correlation of rotational flexibility between two groups was 0.96 at full extension, 0.83 at 45° flexion, 0.86 at 90° flexion and 0.90 at 120° flexion. Overall, correlation was 0.83 between two groups. Overall correlation of varus/valgus flexibility was 0.64.

DISCUSSION

In the well functioned implanted knees, the internal rotation angle of the tibia with the rectangular tibial post during flexion was the same with that with the round tibial post. Even with the longer posterior flange of the femoral component, the knees could have deep flexion angle. The results of the flexibilities showed that the flexibility after TKA depended mainly on the patient condition and partly on the components designs

Our FEM analyses showed that the rectangular tibial post had very high equivalent stress compared with the round tibial post when the tibia rotated 10° internally during flexion. The tibial articular surface of Superflex with longer posterior flange of the femoral component also had high equivalent stress in deep flexion. Therefore, the designs of components are very important. Because the tibia rotates internally during flexion regardless of the shape of the tibial post, the post should have round shape. Design modification of the posterior flange of the femoral component is necessary in order to reduce the contact stress on the tibial articular surface in order to obtain deep flexion angle safely.

Poster: 198
#706

Knee Osteoarthritis Pain Can Be Eliminated Immediately by Focusing on Muscles by Means of Manipulative Compression.

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INTRODUCTION

The main problem associated with knee Osteoarthritis (OA) is pain. Pain renders patients inactive and decrease joint movements by its inactivity disturbs homeostasis of articular cartilage and reduces beneficial mechanical stimuli. It follows that the decreased joint movement accelerates the progression of the disease. Thus, pain leads to even greater pain, worsens the disease pathology and forms a vicious cycle (pain-deterioration chain). Pain relief is a key component of effective treatment of knee OA. Now, we have successfully discovered a manipulative maneuver that can eliminate knee OA pain immediately. We are surprised at the effect of this maneuver.

METHODS

Ten knee OA patients participated in this study. The age of the subjects were from 60 to 87 years. The condition of OA was evaluated with Kellgren-Lawrence Grading Scale (methods of classification of radiographic osteoarthritis) and the Japanese Knee Osteoarthritis Measure (JKOM) index. JKOM index is a modified WOMAC index (Japan Version). Manipulative compression by hand was performed all over the lower-limb muscles of the patients. The lower-limb muscle was strongly-compressed within the range in which the patient does not feel pain, and each compression was held for 20 seconds. Each manipulative compression was performed in linear sequence throughout the lower-limb with pain. The following evaluation items were recorded before and after this therapy: Visual analogue scale (VAS) and muscle stiffness, muscular hemodynamics; oxygen saturation of muscular tissue (StO_2) and total Hb. The evaluated site of muscle stiffness and StO_2 is gastrocnemius. A hardness gauge (DUROMETER; KOBUNSHI KEIKI CO. LTD.) was used to measure muscle stiffness. Near infrared spectrometer (BOM-L1 TR; OMEGAWAVE, INC.) was used to measure muscular hemodynamics.

RESULTS

VAS was reduced from 47.8 ± 20.0 mm to 8.4 ± 9.6 mm (mean ± SD). The relief was a reduction in pain over time. It remains effective for three day. Muscle stiffness was reduced from 7.9 ± 4.0 to 2.8 ± 1.8 (absolute

number). StO_2 increased from 61.4 ± 6.2 % to 66.2 ± 4.9 %. Total Hb was constant. Regardless of knee OA condition (Kellgren-Lawrence Grading, JKOM), this effect was similar.

DISCUSSION

The reduced muscle stiffness reflects release of muscle spasm. Increased StO_2 and unchanged Total Hb reflect an increase in muscular blood flow. It would appear that the analgesic efficacy of this maneuver is due to deprivation of pain sensation by pressure stimulus (gate-control theory) and elimination of waste products and pain producing substances from the muscles by the increase in muscular blood flow. This maneuver acted rapidly against knee OA pain and worked regardless of degree of disability. This research suggests that knee OA pain mainly attributes myogenic disorder and can be eliminated immediately by focusing on muscles by means of manipulative compression.

Poster: 199
#767

The Effect of Residual Necrotic Lesion Volume on the Results of Hip Resurfacing for Osteonecrosis

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Introduction

There remains controversy regarding the indication of resurfacing hip arthroplasty for patients with osteonecrosis (ON). The extent of residual ON in the resurfaced femoral head is considered to be a critical factor for successful hip resurfacing. However, there are few studies where the relationship between the residual ON size and their clinical results was assessed. The purpose of this study was to ask how the extent of residual ON in the resurfaced femoral head affected clinical results of hip resurfacing for patients with ON.

Patients and methods

Between 1998 and 2007, hip resurfacing was performed on 36 hips with ON using the Birmingham Hip Resurfacing. Mean age at operation was 40 years (20 to 59). Mean follow-up period was 7 years (2 to 12). Surgical procedures were performed through a postero-lateral approach. All of the necrotic bone down to the normal bone was removed. Anchoring holes over the normal bone were performed. Femoral component filling with low-viscosity cement was fixed.

3D-MRI based templating was performed using our original software, referencing the component positions and alignments on the postoperative radiographs. Segmentation of the residual ON and the resurfaced femoral head was performed on serial coronal planes. The volumes of the residual ON and the resurfaced femoral head were calculated by summation of their areas on serial coronal planes. The percentage of the residual ON volume in the resurfaced femoral head volume was calculated.

To investigate the effect of the lesion volume on clinical results, the subjects were divided into following two groups based on the percentage volume of residual ON, a small group (less than 25%) and a large group (25% or more).

Results

The mean Merle d'Aubigne score improved from 10.3 before operation to 17.4 at the final follow-up ($p<0.01$). On the radiograph immediately after surgery, the mean cup inclination angle and stem-shaft angle was 41° (31 to 50) and 141° (129 to 154).

The average percentage volume of residual ON was 26.8% (7.9 to 77.2). Nineteen hips were grouped into the small group and 17 hips into the large group. There were no significant differences in age, gender, BMI, cup inclination angle and stem-shaft angle between the two groups. There were no significant differences in Merle d'Aubigne score before surgery and the final follow-up between the two groups.

Femoral component loosening was observed in one in the small group and in one in the large group. The case with 11% of residual ON in the resurfaced head showed femoral component loosening at 6 years and revised at 9 years. The other case with 39% of residual ON in the resurfaced head showed femoral component loosening at 7 months and revised at 10 months. There was no revision surgery for any other reasons. There were no significant differences in loosening and revision rate between the two groups.

Conclusion

The extent of residual osteonecrosis in the resurfaced femoral head had no significant influence on clinical results of hip resurfacing for patients with osteonecrosis of the femoral head.

Poster: 200
#769

Mid-Term Results of Hip Resurfacing for Patients With Osteonecrosis-a Comparison With Osteoarthritis-

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Introduction

It is controversial whether the clinical results of hip resurfacing for patients with osteonecrosis are comparable to those of patient with osteoarthritis. There are a limited number of literatures regarding a comparison of results of hip resurfacing between osteonecrosis and osteoarthritis. The aim of the present study was to compare resurfacing hip arthroplasty for patients with osteonecrosis performed at our institute.

Patients and method

The subjects were 126 patients with 144 hips who had had hip resurfacing between 1998 and 2007 using the Birmingham Hip Resurfacing. They were 36 patients with 42 hips affected with osteonecrosis and 90 patients with 102 hips affected with osteoarthritis. Mean age at operation was 49 years (19 to 85). Mean follow-up period was 7 years (2 to 12). Clinical and radiographic follow-up was performed immediately after surgery, at 3 weeks, 3 months, 6 months and 1 year after surgery, and then annually thereafter.

Survival of implants was determined with actuarial life-table constructs described by Kaplan and Meier. The end points for survival were defined as radiographic failure including components loosening and femoral neck fracture and revision for any reasons.

Results

Mean Merle d'Aubigne score was improved from 10.4 preoperatively to 16.8 at the final follow-up for patients with osteonecrosis and from 9.5 to 17.0 for patients with osteoarthritis. There were no significant differences in Merle d'Aubigne score before surgery and the final follow-up between the two groups.

There were no significant differences in BMI, femoral cortical index, femoral component size, cup inclination angle and stem-shaft angle between the two groups. Patients with osteonecrosis were younger ($p<0.001$) and included more male patients ($p<0.001$).

In patients with osteonecrosis, femoral component loosening was seen in 2 hips at 7 months and 6 years respectively. In patients with osteoarthritis, femoral neck fracture was seen in one hip at 3 weeks and femoral component loosening at 7 years in one hip. Kaplan-Meier survivorship with an end point of radiological failure of femoral component was 92.9%for patients with osteonecrosis and 96.9% for patients with osteoarthritis at 7 years. There is no significant difference in survivorship between the two groups ($p=0.29$, Log-rank test). There was no cup loosening in the two groups. Kaplan-Meier survivorship with an end point of radiological failure of cup was 100% for patients with osteonecrosis and 100% for patients with osteoarthritis at 7 years.

In patients with osteonecrosis, there were two revisions due to femoral component loosening at 10 month and 9

years respectively. In patients with osteoarthritis, there were three revisions due to femoral neck fracture in one hip, femoral component loosening in one hip and infection in one hip. Kaplan-Meier survivorship with an end point of revision was 97.6% for patients with osteonecrosis and 97.8%for patients with osteoarthritis at 7 years. There is no significant difference in survivorship between the two groups (p=0.47, Log-rank test).

Conclusion

The mid-term result of resurfacing hip arthroplasty for patients with osteonecrosis was excellent and comparable to those for patients with osteoarthritis.

Poster: 201
#657

Cadaveric Results of a Hand-Held, Pinless Navigation System for the Tibial Resection in Total Knee Arthroplasty

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INTRODUCTION:

In total knee arthroplasty (TKA), conventional intramedullary (IM) and extramedullary (EM) tibial alignment guides have only been shown to be 72% and 88% accurate, respectively, in obtaining a varus/valgus tibial component alignment within 2° of perpendicular to the mechanical axis. The objective of this study was to determine the efficacy and time associated with the use of a hand-held, surgical navigation system in obtaining a specific tibial resection alignment in both the coronal and sagittal planes.

METHODS:

20 cadaveric specimens (hip-to-toe) were included in this study. 4 orthopaedic surgeons performed a tibial resection utilizing the KneeAlign^{TM} system, each on 5 separate tibiae. Prior to each resection, the surgeon was assigned a specific "goal" of tibial varus/valgus (1° of valgus to 4° of varus) and posterior slope (2° to 5°) to achieve.

The KneeAlign^{TM} is a hand-held, accelerometer based console attached to an EM tibial jig. After calibration, the tibial jig is used to register the medial and lateral malleoli, to establish the tibial mechanical axis. The display console provides real-time feedback of both the tibial cutting block's varus/valgus alignment and posterior slope prior to performing the tibial resection.

For each procedure, the time from which the surgeon was handed the device, to the point immediately prior to cutting the tibia, was recorded (in seconds). Varus/valgus alignment relative to the mechanical axis in the coronal plane, and posterior slope relative to the mechanical axis in the sagittal plane, were measured (in degrees) on both plain radiographs and computed tomography (CT) from the knee to ankle.

RESULTS:

With regards to varus/valgus alignment, CT evaluation demonstrated 95% of the tibial resections to be within 2° of the pre-operative "goal." The mean difference between the final varus/valgus position of the tibial resection and the pre-operative "goal" was 0.68° + 0.46° using CT, and 0.20° + 0.99° using plain radiographs. The mean difference between the posterior slope of the tibial resection and the pre-operative "goal" was 0.7° + 0.47° using CT, and 0.43° + 1.16° using plain radiographs, with 95% of the tibial resections within 2° of the pre-operative "goal." The time required to use the KneeAlign^{TM} was less than 450s for the first specimen, and less than 300s for the fifith specimen, for all 4 surgeons.

CONCLUSION:

The KneeAlign^{TM} system provides intraoperative, real-time feedback to the surgeon via a hand-held console attached to the EM jig. It is compatible with all TKA systems, making it user-friendly for surgeons acclimated to the use of EM alignment guides. Most importantly, the KneeAlign^{TM} system is highly accurate in obtaining a specific varus/valgus alignment and posterior slope of a tibial resection, and the ability to adjust both the coronal and sagittal alignments intraoperatively may prove clinically useful in total knee arthroplasty.

Poster: 202
#658

Radiographic Analysis of a Hand-Held, Accelerometer Based Surgical Navigation System for the Tibial Resection in Total Knee Arthroplasty

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INTRODUCTION:

In total knee arthroplasty (TKA), conventional intramedullary (IM) and extramedullary (EM) tibial alignment guides have only been shown to be 72% and 88% accurate, respectively, in aligning a tibial component within 2° of perpendicular to the coronal mechanical axis. The objective of this study is to determine the accuracy of a hand-held, accelerometer based surgical navigation system in obtaining a postoperative tibial component alignment within 2° of the intraoperative goal in the coronal and sagittal planes, respectively.

METHODS:

This is a prospective cohort study of 151 TKAs performed by two surgeons utilizing a hand-held, surgical navigation system to perform the tibial resection. Included patients had a mean age of 62.6 + 11.0 years, and a mean body mass index of 31.1 + 6.2 kg/m2.

The KneeAlign^{TM} is a hand-held, accelerometer based console attached to an EM tibial jig (Figure 1). After calibration, the tibial jig is used to register the medial and lateral malleoli, to establish the tibial mechanical axis. The display console then provides real-time feedback of both the tibial cutting block's varus/valgus alignment and posterior slope prior to performing the tibial resection.

Postoperatively, standing anteroposterior hip-to-ankle radiographs, and lateral knee-to-ankle radiographs were performed to determine the varus/valgus alignment and the posterior slope of the tibial components relative to the mechanical axis in both the coronal and sagittal planes. The accuracy of the system was assessed by measuring the difference between the intraoperative reading of the cutting block's alignment prior to performing the tibial resection, and the radiographic measurement obtained postoperatively for each, respective case.

RESULTS:

95.3% of the tibial components were placed within 2° of the intraoperative goal in the coronal plane, and 96.1% of the components were placed within 2° of the intraoperative goal in the sagittal plane. Overall, the mean, postoperative lower extremity alignment was -0.3° + 2.1°, with 97.0% of patients having an alignment within 3° of a neutral mechanical axis.

CONCLUSION:

The KneeAlign^{TM} system provides intraoperative, real-time feedback to the surgeon via a hand-held console attached to the EM jig. It is compatible with all TKA systems, making it user-friendly for surgeons acclimated to the use of EM alignment guides, while avoiding the costs of capital equipment purchases associated with computer-assisted surgery systems. Most importantly, the KneeAlign^{TM} system greatly improves the accuracy of tibial component alignment in TKA compared to prior published accuracy rates of conventional IM and EM tibial alignment guides, and the ability to adjust both the coronal and sagittal alignments intraoperatively may prove clinically useful in total knee arthroplasty.

Poster: 203
#659

The Effect of 5 Millimeter Osteochondral Defects on Coronal Plane Knee Stability- a Cadaveric Study

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INTRODUCTION:

In varus knee osteoarthritis, patients often present with variable amounts of denuded articular cartilage and bone loss in the medial compartment, however the quantitative effects of osteochondral defects on both leg alignment and coronal stability are poorly understood. The purpose of this study was to quantify the overall coronal plane laxity in the native knee throughout flexion, and determine the effects of osteochondral defects of the medial distal femoral condyle (MDF), medial posterior femoral condyle (MPF), and medial tibial plateau (MT), on coronal plane stability.

METHODS:

5mm osteochondral defects were simulated in ten cadaver limbs by sequentially removing subchondral bone and cartilage off of the MDF, MPF, and MT. Computer navigation software and a robotic cutting-guide were used to standardize the depth of the osteochondral defects in each location. The navigation software was used to measure alignment and stability of the knee at 0°, 30°, 60°, and 90° of flexion. Moments of 9.8Nm in varus and valgus were standardized using a 4kg spring load applied 25cm distal to the joint line.

A repeated measures ANOVA was performed to analyze whether a difference was present in the mean mechanical varus alignment angle at each degree of flexion, both between the native knee and each individual defect, and between the native knee and all defects combined.

RESULTS:

In the native knee, coronal laxity increased with flexion, ranging from 2.2° + 1.5° at 0° of flexion, to 10.8° + 4.2° at 90° of flexion. The MPF defect increased varus opening at 90°of flexion by 3.3° + 1.2° ($p=0.019$), but did not show a significant difference from 0° to 60° of flexion. The MDF defect resulted in an increase in varus laxity at 0° (2.2° + 1.7°, $p=0.037$) and 30° of flexion (2.1° + 1.3°, $p=0.023$), but not at 60° of 90° of flexion. The MT defect increased varus opening at all flexion angles by 4.0° to 7.0°, but was only statistically significant at 30°of flexion ($p=0.026$). With all defects present, varus laxity increased at all flexion angles by 4.0° to 7.7°.

DISCUSSION AND CONCLUSION:

Defects in the medial distal femur significantly altered stability in 0° and 30° of flexion, posterior femoral condyle defects significantly altered stability in 90° of flexion, and tibial defects affected coronal stability throughout flexion. The quantitative values presented in this study may help surgeons with preoperative templating and intraoperative decision making when balancing both a total knee and unicondylar arthroplasty.

Poster: 204
#916

Novel Strontium-Substituted Bioactive Glass Implant Coating Compared to Hydroxyapatite in a Lapine Model

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Background:

There is a need to enhance implant fixation particularly in osteoporotic patients. One approach to achieve this is through the development of novel implant coatings, such as a strontium-substituted bioactive glass. Bioactive glasses are ceramics typically containing a silica content of 40-45 mol.%. When exposed to physiological fluids, the glasses dissolve releasing silicon and other cations which help lead to the formation of a silica gel layer onto which hydroxyapatite precipitates. Strontium is recognised for its beneficial effects on bone at specific concentrations. Strontium containing bioactive glass coatings may offer a promising approach for enhancing

implant fixation and based upon published findings it is expected that any beneficial effects will be directly related to the degree of substitution of strontium within the bioactive glass.

Aim:

The aim of this study was to investigate the degree of osseointegration and new bone formation associated with a new strontium-substituted bioactive glass Ti-alloy implant coating compared to a commercially available hydroxyapatite coating.

Method:

Appropriate legal and ethical approval was obtained for this study from the UK Home Office. Bioactive glass in the system: SiO_2-MgO-Na_2O-K_2O-ZnO-P_2O_5-CaO, with 50% of the calcium being replaced by strontium, was prepared through a melt-quench technique and milled to produce a particle size distribution similar to that of a commercially available hydroxyapatite implant coating. Identical alumina grit-blasted Ti6Al4V cylindrical implants were coated with either strontium-substituted bioactive glass or hydroxyapatite. Implants were surgically placed utilising a press-fit technique into the distal femur and proximal tibia bilaterally of twenty-seven skeletally mature New Zealand White rabbits. Mechanical pushout testing and histological evaluation of bone-implant contact and peri-implant bone formation was performed at six, twelve and twenty-four weeks post-implantation. Statistical analysis was performed using Mann-Whitney U Test or Wilcoxon Sign Rank Test as appropriate.

Results:

Two rabbits were excluded from the study, one due to infection and one due to fracturing around an implant. Mechanical pushout testing revealed a trend for increasing maximal shear strength over the course of the experiment in the strontium-substituted bioactive glass group, with a statistically significant difference noted at twenty-four weeks compared to the hydroxyapatite group (5.0MPa vs 3.9MPa, p=0.028). Analysis of the implants following pushout showed that the strontium-substituted bioactive glass coating had dissolved by six weeks, with the mechanism of failure suggesting initial implant fixation was principally mechanical (i.e. keying of the implant to the bone rather than direct bone-coating integration). Histologically no difference between groups was seen in bone-implant contact at any time-point. However, greater peri-implant bone was found in the strontium-substituted bioactive glass group at all three time points, although statistical significance was only achieved at six weeks (mean 69.5% vs 55.9%, p=0.017).

Conclusion:

This novel strontium-substituted bioactive glass coating produces enhanced fixation of implants in bone in a non-weight bearing lapine model, compared to hydroxyapatite.

Poster: 205
#1112

Ultrasound Screening of Periarticular Soft-Tissue Abnormalities Around Metal, Ceramic, and Polyethylene Bearings

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Although metal hypersensitivity or pseudotumors are concerns for metal-on-metal (MoM) bearings, such reactions around ceramic or polyethylene bearings are incompletely understood. We examined capabilities of ultrasound screening and compared prevalence of periarticular soft-tissue lesions among various types of bearings. Ultrasound examinations were conducted in 163 hips (153 patients) with arthroplasty of 5 different bearings, and magnetic resonance imaging (MRI) was subsequently performed in 45 hips. Using soft-tissue lesions on MRI as reference, positive and negative predictive value, and accuracy of ultrasound examination were 83%, 71%, and 78%. Abnormal ultrasound lesions were most frequently observed in total hip arthroplasties (THAs) with conventional polyethylene liner (50%), followed by MoM THAs (25%), THAs with highly cross-linked polyethylene liner (23%), MoM hip resurfacings (18%), and ceramic-on-ceramic THAs (14%). Various soft-tissue reactions could be observed other than MoM bearings, and ultrasound examination may be a suitable screening tool of soft-tissue reactions around various bearings.

Poster: 206

#535

SPECT Scanning Confirms That Femoral Head Augmentation in Hip Resurfacing Is a Viable Surgical Technique

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Introduction

Metal-on-metal hip resurfacing (MOMHR) has traditionally been contraindicated in patients with severe insufficiencies of the femoral head/neck. We developed a new surgical technique to treat these patients.

Description of Technique

Using specially designed surgical instruments, bone chips obtained from acetabular reaming and femoral head trimming are impacted onto the deficient femoral head, followed by standard MOMHR.

Patients and Methods

A retrospective study was conducted on 27 hips treated with this technique. The primary diagnoses were congenital hip dysplasia, Perthes disease, and osteonecrosis. The Harris hip score (HHS) was assessed at the last follow-up. Leg length and implant positioning were assessed radiographically, both post-operatively and at a mean follow-up of 4.9 ± 2 years (3 to 9). Technetium-99m-hydroxymethane diphosphonate (administered activity of 700-740 MBq) bone scintigraphy was performed on 3 hips to assess the viability of the grafted bone underlying the prosthesis. The follow-up times were 1, 4 and 7 years respectively. A three-phase bone scan was performed with a 2 head gamma camera (Infinia™ Hawkeye®, GE Healthcare), including perfusion, blood pool and late (2 hours) whole body and anterior and posterior planar views and SPECT/TC of the pelvis. Pin-hole images of two hips were acquired with a single head gamma camera (Apex SP6, Elscint). SPECT/CT data were processed by interactive reconstruction to minimize artifacts due to metallic implants. Bladder activity and images were displayed in transaxial, coronal and sagittal planes.

Results

Mean HHS was 98 ± 1.6 compared with 61 ± 8.8 pre-operatively. Mean radiographic leg length discrepancy was 16 ± 0.49 mm and 0.1 ± 0.58 mm prior and after surgery respectively. Mean femoral head lengthening was 14.8 ± 3 mm (8 to 18 mm).

With regards to bone scintigraphy, in the dynamic and blood-pool phase, no abnormal distribution of the tracer was observed in either the treated or untreated femoral head. In the static images at 2 hours (Fig. 1A-B) and at SPECT/TC (Fig. 1C-D), there was a small area of attenuation in the superior portion of the femoral head, consistent with the presence of the prosthesis. In this area, the activity was similar to that of the normal contralateral femoral head, inferring preserved vascularity. There was no visual evidence of osteonecrosis at long-term after surgery. Other than the areas of mildly reduced activity created by the stem of the femoral prosthesis, in planar (Fig. 2A-B) and pin-hole images (Fig. 2C-D), no photopenic areas were identified in the proximal portion of the femur of any implant, indicating that there were no identifiable areas of osteonecrosis. Of particular importance are the pin-hole images which show that the activity in the treated femoral head is evenly distributed and similar to the contralateral native head (Fig. 2C-D).

At the last follow-up, X-rays showed no signs of femoral component loosening. One hip was revised due to acetabular component loosening.

Conclusions

Femoral head augmentation in conjunction with MOMHR is a promising surgical procedure for use by the hip resurfacing specialist. SPECT scanning shows that the grafted bone remains viable over time.

The Relationship Between Nanostructured Titanium Substrates Produced by High Pressure Torsion and Surface Bioactivity

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Introduction

Mesenchymal stem cells can attach to the implant surface, differentiate into bone-forming cells and ultimately osseointegrate with the prosthesis. Ideal osteocompatible biomaterials should allow good and tight cell attachment, support cell viability, promote new bone mineral deposition and simultaneously should inhibit bacterial adhesion. In recent years, nanostructured materials have been suggested as the next generation of orthopaedic and dental materials due to their excellent properties compared with conventional coarse-grained materials [1,2]. In this study, the effect of grain size of polycrystalline titanium substrates on mouse bone marrow-derived mesenchymal stem cell (mBMMSC) and bacterial adhesion are investigated. Moreover, the cytotoxic effects of Ti substrates and the ability of hydroxyapatite formation on their surfaces in a simulated body fluid (SBF) are evaluated.

Materials and methods

Slices of commercially pure Ti extruded rod were used to make nanostructured substrates by high pressure torsion and coarse-grained sample by heat treatment. Cell attachment was conducted using mBMMSCs cultured on Ti substrates with different microstructure as described in [3]. The cytotoxicity of the samples to mBMMSCs was assessed using MTT assay after 1, 3 and 7 days of culture. The formation of the apatite crystals on the surface of the substrates having different microstructures was observed using SEM after 1, 3 and 7 days of incubation in SBF [4] Finally, to evaluate the adhesion of *S.aureus*, different Ti samples were incubated in bacterial suspension for 2, 4 and 12 h and visualized with SEM.

Results

The number of attached mBMMSCs on the surface of nanostructured Ti substrates was significantly higher than on the surface of the coarse-grained and untreated samples after 4 h of incubation. MTT assay revealed that mBMMSCs grown on nanostructured Ti samples have significantly higher cell viability compared to those on two other samples. SEM micrographs of Ti substrates after 1 day of soaking in SBF showed that some small-size depositions started to form on the surface of the substrates. Nevertheless, the surface of nanostructured substrates was not fully covered with the apatite crystals after 7 days (Fig 1). The number of bacterial cells attached to the surface of nanostructured Ti samples was significantly reduced than on two other Ti samples in all time point tested.

Discussion and conclusion

The surface of nanostructured Ti substrates present unique oxide layer in both structure and composition [1]. It has been shown that this leads to higher surface hydrophilicity and energy as well as higher expression of biomolecules, most importantly fibronectin [3]. Therefore, improved cellular adhesion and bioactivity and also reduced bacterial adhesion could be correlated to higher expression of fibronectin and hydrophilicity on the surface of nanostructured Ti samples. In summary, nanostructured Ti substrates produced by high pressure torsion would be a promising alternative to conventional titanium based materials as it provides both higher surface bioactivity and enhanced bulk properties which could lead to early implant fixation and improved osseointegration.

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Figures

Poster: 208
#1110

Mouse Bone Marrow-Derived Mesenchymal Stem Cellular Response to Nanostructured Titanium Substrates Produced by Highpressure Torsion

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Mesenchymal stem cells can attach to the implant surface, differentiate into bone-forming cells and ultimately osseointegrate with the prosthesis. This study investigates bone marrow-derived mesenchymal stem cellular response to the grain structure of titanium substrates produced by high-pressure torsion (HPT) and annealing processes. Cell attachment, proliferation, viability and morphology are evaluated on the surface of differently processed nanostructured and coarse-grained samples. The bacterial adhesion and calcium phosphate crystal formation and growth is also assessed on the surface of the substrates. The nanostructured titanium show significantly higher cell adhesion, proliferation, spreading and viability compared with the untreated and coarse-grained titanium substrates. The adhesion of bacteria is lower and surface bioactivity is higher on the surface of nanostructured titanium substrate. The results demonstrate the superior mesenchymal stem cell compatibility, antibacterial efficacy and surface bioactivity of the nanostructured titanium substrates which could lead to early implant fixation and improved osseointegration.

Poster: 209
#570

Early Administration of Fondaparinux and Enoxaparin in Total Knee Arthroplasty in Japanese Patients

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Background

The validity of fondaparinus and enoxaparin has been reported in the prevention of deep vein thronbosis and pulmonary embolism (DVT/PE) after total knee arthroplasty (TKA) in Japan. We compared the effectiveness of early administration of these two drugs after TKA in Japanese patients.

Methods

We studied 32 Japanese patients who underwent TKA in the period between May 2009 and May 2010. The operations were performed under general anesthesia and femoral nerve block, using an air tourniquet, and using cements for implant fixation. These patients were divided in two groups, use of 2.5mg fondaparinux once daily (F group), and use of 2000IU of enoxaparin twice daily (E group). The initial dose was administered between 12 and 21 hours after surgery and continued for 14 days. We compared the incidence of DVT/PE, bleeding complications, D dimer level, and hemoglobin (Hb) loss.

Results

DVT/PE occurred in 6 patients (38%) in the F group, and 3 (19%) in the E group.(See Fig.1) Bleeding complications occurred in none of the Fa group and 4 (25%) in the Ex group.(See Fig.2) There were no significant differences in D dimer level and Hb loss.

Conclusion

Our study showed that there are some differences in the characteristics of fondaparinux and enoxaparin, and that consideration should be given to their mode of administration to Japanese patients.

Figures

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Figure 2

Poster: 210
#864

Does Intense Sport Activity Affect Total Hip Arthroplasty Durability?

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Introduction:

Beside expert recommendations, very little is known on total hip arthroplasty (THA) durability for patients involved in high sportive activities. The goal of the present study was to compare clinical outcome, polyethylene wear and prosthesis survival of THA for patients with high sportive activity to a control group at a minimum follow-up of 10 years.

Material and Methods:

The study included 200 patients implanted with a cementless THA using ceramic head and conventional polyethylene. Mean age was 58 +/-2 years, mean BMI 25.5kg/m² and 93 were men. The patients were evaluated for sportive activity, satisfaction and quality of life using UCLA and HOOS scores. Linear polyethylene wear was measured using IMAGIKA. Patients with high sportive activity (UCLA > 8) were compared to control matched patients.

Results:

At 10 years, the clinical score was higher ($p < 0.05$) in the sporting patient group (92.17 points) compared to the control group (77.4 points). The HOOS score was statistically higher for all items in the sporting group. The mean linear polyethylene wear was 0.168 mm/year in the sporting group versus 0.06 mm in the control group ($p=0.0001$), but no statistical difference was found for prosthesis survival between the two groups.

Discussion and conclusion:

This study showed higher clinical and quality of life scores for patients involved in sporting activities with no difference in prosthesis survival compared to non sportive patients. Polyethylene wear was higher in the sportive group reinforcing bearing surface choice in such category of patients.

Poster: 211
#660

Measurement of the Glenoid Track in Vivo, Investigated by the 3D Motion Analysis Using Open MRI

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INTRODUTION

Hill-Sachs lesion is a common injury associated with anterior glenohumeral instability. One factor thought to be related to recurrent instability is a significant bony defect of the humeral head that engages with the anterior glenoid rim ("engaging Hill-Sachs lesion"). To our knowledge, no anatomic or biomechanical studies to date have clarified which size of Hill-Sachs lesion is critical. Recently, Yamamoto et al. (JSES 2007) measured in a cadaveric study the contact between the glenoid and humeral head in abduction, external rotation, and horizontal extension. They proposed a new concept "glenoid track" to evaluate the risk of engagement with the glenoid. The purpose of this study was to investigate the "glenoid track" *in vivo* using non-invasive motion analysis system developed in our laboratory.

METHODS

We examined 30 right shoulders of 30 healthy volunteers (17 males, 13 females, mean age of 24 yrs). None of them had shoulder pain or medical history of shoulder joint disorders. The subjects lied supine on the table of an open MRI machine. MRI was taken in seven static positions with the arm from 0° to maximum abduction keeping maximum external rotation and horizontal extension. The custom made device was used to keep the arm in each

position without restricting the physiological movement of the scapula. We used 3D-flash method with a loop coil around the shoulder. Using our motion analysis system, three-dimensional models of the scapula and humerus were created from the MRI data by segmentation. Then, the movement was calculated by voxel-based registration of each model. After this motion visualization process, motion of the glenoid on the humeral head was analyzed. We measured the width of the glenoid track which was the distance from the medial margin of contact area to that of the footprint at 60°, 90°, 120° and 150° of abduction. The present study was approved by the ethics committee of our hospital and all participants gave informed consent to participate in this study.

RESULTS

The images clearly demonstrated that the glenoid shifted from infero-medial to supero-lateral portion of the humeral head. The width of the glenoid track at 60° of abduction was 19.4 mm ± 3.9 mm (mean ± SD), which was equivalent to 83% ± 12% of the glenoid width.

DISCUSSION

In the present study, we measured the size of the "glenoid track" *in vivo.* The *in vivo* width of the glenoid track was almost equal to the value measured in cadaver[fig.1, fig.2]. With this concept, we are able to assess the risk of engaging Hill-Sachs lesion[fig.3]. The risk of engagement depends on the location of Hill-Sachs lesion as well as the existence of bony glenoid defect. The limitation of this study was that these measurements were done using MRI taken under sequential static conditions in supine positions, which may or may not be different from the ones during dynamic activities. We believe that this new concept is useful in evaluating the risk of Hill-Sachs lesions.

Figures

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Figure 8

Poster: 212
#479

29 to 24 Year-Clinical Results of Total Hip Arthroplasty Cemented With HA by Interface Bioactive Bone Cement (IBBC)

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[Introduction]:

In 1982, we applied Interface Bioactive Bone Cement technique (IBBC) in six hips after getting excellent results in animal experiments. As we got excellent results in all clinical cases, IBBC was used in all cases of THA since 1985.

[Material and Methods]:

For total hip prostheses 28 mm-alumina head with conventional all polyethylene socket of over 10 mm in thickness (Kyocera Co.) were used in all cases. In IBBC technique not-resorbable pure crystalline porous HA granules of 300 – 500 μm in diameter were smeared on the bone surface in one to three layers just before packing bone cement on the bone.

Group 1 : IBBC was used in six joints in 1982. They were 29 years after surgery.

Group 2 : In 25 patients, conventional bone cement technique (non-IBBC) in the one hip (in 1985 to 1986) and IBBC technique in the other hip (in 1986) were performed in the same patients. They were 26 to 25 years after surgery. Follow-up rate was 92%.

Group 3 : In 212 patients (285 joints) IBBC were performed in OA (227 joints), RA (30 joints) and ANF (8 joints) in 1986 to 1987. They were 25 to 24 years after surgery. Follow-up rate was 91%. Radiographical findings were observed.

[Results]:

In group 1 two patients died. A graft-bone on the margin of the dysplasic acetabulum was absorbed partially in one joint. Neither radiolucent line nor osteolysis appeared in all cases.

In group 2 in the hip joints with Non-IBBC the appearance rate of radiolucent line and osteolysis were rather high, however in the hip with IBBC they were extremely low. In Non-IBBC loosening were seen in 5 joints in the acetabulum and in 2 joints in the femur. However, in IBBC there was no loosening.

In group 3 the radiolucent line appeared in Zone 3 and 4 in 0.9 to 1.4%, and the osteolysis appeared in Zone 1 and 2 in 0.5%. They were extremely low. There was no loosening. Revision was performed in one joint of late infection. The linear wear rate was 0.13 mm/year in average in all groups.

[Discussion]:

In conventional bone cement (Non-IBBC) 26 to 25 years after surgery the appearance rate of radiolucent line and the osteolysis was very high and the rate of loosening was 20%. However, in IBBC, as not-resorbable and osteoconductive HA granules were interposed between bone and bone cement, the appearance of radiolucent line and osteolysis was prevented even 29 years after surgery, and could be prevented eternally.

[Conclusion]:

Extremely long term longevity of the fixation at the interface of bone and bone cement will be expected in IBBC.

Poster: 213
#1012

Impaction Auto-Bone Grafting With Metal Mesh for Acetabular Reconstruction in Primary Cemented Total Hip Arthroplasty for Dysplastic Hip

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Background:

In cemented total hip arthroplasty (THA) for severe dysplastic hip, a massive auto-bone graft from the femoral head is required for acetabular reconstruction. However, crushing and absorption of the grafted bone can lead to cup loosening. In revision THA using the impaction bone grafting (IBG) technique with metal mesh, the long-term outcome is good. Therefore, we performed primary cemented THA using this technique for acetabular reconstruction in dysplastic hip.

Patients and Methods:

Between 2001 and 2004, we performed 17 primary cemented THAs using the IBG technique with metal mesh in 15 patients with severe dysplastic hip (17 women; mean age at operation, 60 years; age range, 48–67 years). Mean follow up was 8.1 years (range, 6.2–10.1 years), with none of the patients lost to follow up. According to Crowe's classification, subluxation was Group I in four hips, group II in 7 hips, group III in 4 hips, and group IV in 2 hips that had undergone femoral shortening osteotomy. We used a Charnley flanged cup (DePuy, Leeds, United Kingdom), Exeter stem with a 22-mm diameter metal head (Stryker, Benoist Girard, France), and Simplex-P bone cement (Stryker, Limerick, Ireland) in all hips. A posterolateral approach was performed for all patients. For the anatomical hip center, we reamed the true acetabular fossa until reaching the acetabular floor, using a suitable hemispherical reamer. The metal mesh (Stryker) with AO small cortical screws was used for acetabular reconstruction in all hips. Bone chips (8 mm diameter) taken from the autologous femoral head in 11 hips and from the femoral head and trochanteric cancellous bone in 6 hips were morselized with a large rougeur to prepare for grafting. We impacted the bone tightly with impactors and a metal hammer. We made multiple 6-mm anchor

holes, cleaned the host acetabular bed with pulse lavage, and dried it with hydrogen peroxide. After using an Exeter balloon pressurizer, the Charnley flanged cup was cemented into the acetabular cavity.

Results

The mean Merle d'Aubigne and Postel functional hip score was significantly improved from 9.1 points (SD 1.4) preoperatively to 17.0 points (SD 1.2) at latest follow up ($p<0.05$;Wilcoxon rank-sum test). All cups were positioned at Pagnano zone 1. Mean socket center-edge angle was -19 degrees (range, -1 to -28). Radiographic outcomes showed no radiolucent lines, broken mesh or screws, or cup loosening at final follow up. Incorporation of the grafted bone, which was determined by the appearance of a continuous trabecular pattern from the host bone surface into the grafted bone, was apparent in all cases. Kaplan-Meier survival was 100% at 10 years with loosening as the end point.

Conclusion

IBG with a mesh is a promising method for acetabular reconstruction in primary cemented THA for severe dysplastic hip.

Poster: 214
#1030

Pre-Clinical Evaluations on Uncemented Acetabular Component Designs

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Despite the generally inferior clinical performance of acetabular prostheses as compared to the femoral implants, the mechanics of acetabular reconstruction remains scarcely investigated [1,2]. The aim of the study was to understand the load transfer in natural and implanted pelvic bones and its relationship with failure mechanisms.

The 3-D FE model of a natural right hemi-pelvis was developed using CT-scan data. The same bone was implanted with two uncemented acetabular component designs – metallic and composite cups, with 54 mm outer diameter (Fig. 1). The FE models of the implanted pelvis were generated using a submodelling approach, which were based on an overall reference solution of a natural pelvis model acted upon by hip joint reaction force and twenty one muscle forces [3,4]. A link between the submodel with a prosthesis and the overall model can be established by transferring the displacements (at nodes) from the overall model at the cut-boundary to the submodel. The FE models for the metallic and the composite cups contained ~ 116000 and ~115000 number of tetrahedral elements. The composite cup consisted of 3mm thick 30% CFR-PEEK (E=12.8 GPa). Bone geometry and inhomogeneous material properties were derived from CT-scan data. The apparent density (ϱ in g cm^{-3}) for each element was calculated using linear calibration of CT numbers of bone, from which the Young's modulus (E in MPa) was determined using the relationship, $E = 3790\ \varrho^{3}$. Contact elements with friction coefficient $\mu = 0.5$ were simulated at the implant-bone interface. Applied loading conditions were based on eight different phases of a normal walking cycle. The hip contact force was applied through the femoral head. Fixed constraints were applied at the pubis and at the sacroiliac joint.

Stress distributions were obtained for all load cases, the results for phase 2 (beginning of single support phase; 13% of gait cycle) are emphasised. The submodelling technique resulted in similar stress patterns between full model and the submodel of the implanted pelvis (Figs 2,3). For the metallic cup, von Mises stresses of 10-20 MPa were generated around the superior acetabular roof, located superior to the acetabulam (Fig 3). In comparison, the composite cup generated higher stresses (15-25 MPa) in the periacetabular region. However, the stresses in the underlying cancellous bone for the composite cup appeared to be more physiological than the metallic design. The effect of stress shielding, a reduction of 50-70% stress, was observed in the bone underlying the metallic implant. This analysis suggests that cementless metallic cup substantially affected periacetabular stress distribution and may result in adverse bone remodelling. The maximum implant-bone sliding micromotion for both designs was restricted to ~108 micron, which suggests probable bone ingrowth into the coated surface of the implant. However, sliding micromotions for the composite cup was less than the metallic cup.

References

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Figures

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Poster: 215
#608

Postoperative Periprosthetic Femoral Fractures After Total Hip Replacement. a Retrospective Study of 26 Fractures Treated From January 2005 to March 2011

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Postoperative periprosthetic femoral fractures after total hip replacement. A retrospective study of 26 fractures treated from January 2005 to March 2011.

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The treatment of the periprosthetic femoral fractures is demanding due to associated comorbidities, elderly and, frequently, poor quality of bone. The fracture patterns correlated to several and new designes (small, less invasive, proximal) of prosthesis and the presence of the implant at the fracture site make the management rather difficult.

Between January 2005 and March 2011 26 fractures in 25 patients have been treated in our Department. Five patients were males and 20 were females (M:F ratio = 1:4) with average age of 78,3 years (range, 61 y to 94y). The average follow-up period was 2,4 years (6 months - 5 years).

The patients were assessed preoperatively following the Vancouver Classification: 2 fractures type A, 19 fractures type B, 4 fractures type C.

Follow-up was performed at one, three and six month after surgery considering: WOMAC and Harris Hip Score. The quality of life was assessed using the SF-12 grading system.

Two options have been considered: open reduction and internal fixation were performed when the implant appeared fixed to one of the mean fragments (23 fractures); the Dall Miles (Stryker), LCP plate with locked screws, cables (Synthes) or both were used; in one case of very proximal B1 fracture the hook plate and locking attachment plate (Synthes) were applied; the patiens with clear loosening of the implant underwent partial revision arthroplasty (3 uncemented femoral stem revisions: Profemur Wright in 1 case and Restoration Stryker in 2 cases).

Neither hardward failure nor loosening of the revision arthroplasty have occured.

At the follow up the average Harris Hip Score moved from 25.86 after surgery to 48.25 (p<0,001) after 24 months and the subjective evaluation using SF-12 moved from 26,54 after one month from the surgery to 46,71 at the last follow-up (p<0,001).

In conclusion we think that open reduction and internal fixation - using plates, locked screws, cables, attachment plates - may be a successfull method in the treatment of periprosthetic femoral fractures without loosening.

Poster: 216
#860

Mid-Term Outcomes of Second Generation High-Flexion Metal-Backed Unicompartmental Arthropasties

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Introduction:

Unicompartmental knee arthroplasty (UKA) has proven its efficacy in treating knee osteoarthritis and has the advantage of preserving bone stock. To improve function and limit wear, a new generation UKA including high-flexion design and cross-linked polyethylene has been developed. We aimed to evaluate function, quality of life, radiological results and survivorship of this implant at a minimum of two years follow-up.

Methods:

From March 1st 2004 to March 1st 2008, 117 medial UKA were consecutively implanted on 107 patients with an average age of 67 years old. The average follow-up was four years (2.0-7.0). Patients were prospectively followed with the Knee Society Score and the Knee Osteoarthrisitis Outcome Score (KOOS). The range of movement was evaluated and the alignment was measured radiographically using the HKA angle by an independent observer.

Results:

At an average follow-up of four years (2 to 7 years), mean Knee Society Knee and Function scores respectively improved from 55 and 62 points pre-op to 96 and 89 points at the latest follow-up. The Flexion remains constant from 128° pre-op to 130° post-op. Patients significantly improved all their items of the KOOS. Four knees were revised to total knee arthroplasties at an average of 17 months post-op, one for infection, one for medial tibial plateau fracture and two for progression of osteoarthritis in the other compartments. The survivorship using revision for all causes was 96.6% at 4-years follow-up. No aseptic loosening was noted in our series.

Discussion and Conclusion:

The results of our series demonstrated that this second generation of implant provides excellent pain relief and allows a high functional level. The absence of aseptic loosening at 4-years follow-up compares favorably with other implants reported in the literature. A careful selection of patients remains essential to diminish late complications following UKA. Longer follow-up will probably demonstrate the advantages of new polyethylene generation.

Poster: 217
#862

In Vivo Acoustic Analysis of Noisy Ceramic-on-Ceramic THA

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Background:

Ceramic-on-ceramic (CoC) bearings in THA are a popular alternative to overcome wear concerns of traditional metal-polyethylene bearings. Several reports, however, have noted the existence of audible noise from certain CoC bearings. The primary purpose of this study was to analyze the sound produced by noisy CoC hips, and secondarily to determine its prevalence and functional impact in our cohort of patients.

Methods:

From July 2002 to November 2008, 46 ceramic-on-ceramic THA were implanted in 41 patients of our academic center. There was 17 men and 24 women with an average follow-up of 2.5 years. Prevalence of noise was evaluated by a patient-administered questionnaire. Patients were then submitted to an extensive in vivo acoustic analysis including amplitude (dB) and frequency (Hz) measurements. Sound emitted from the CoC joint was recorded using two different microphones while patients performed four different tasks (walking, bending, climbing and twisting) in a neutralized, soundproofed studio. The sound analysis was correlated with the patient movements. A radiographic evaluation was conducted to measure cup acetabular angle and hip offset. All patients were assessed regarding their function by pre-op and post-op WOMAC scores. Patient charts were reviewed to document implants type and size as well as any medical or surgical complications. The statistical analysis was conducted using the Wilcoxon test.

Results:

Thirty-three patients (80,5%) responded to the questionnaire. Two were lost to follow-up and six did not respond. Seven (21%) patients admitted hearing noise from their CoC THA. This was on a daily basis for five patients. The acoustic analysis characterized two different types of noise: squeaking and knocking. These two types of noises varied widely in duration and frequency. Squeaking noises were more than 200 ms in duration and demonstrated precise frequencies with harmonic resonance, while knocking noises were less than 20 ms in duration and were expressed in a wide range of frequencies (200 – 2000 Hz). The average amplitude was 55 dB for both types of noise. The pre-op WOMAC scores for noisy patients and silent patients were similar, respectively 150,5 and 142,9. All patients were markedly improved at final follow-up. However, silent hips had better post-op WOMAC pain scores (10,3 vs 6,7 $p \leq 0.03$), functional scores (33,2 vs 16,8 $p \leq 0.03$) and total scores (47,9 vs 23,6 $p \leq 0.029$).

Conclusions:

The noisy hip is a phenomenon that is unique to total hip replacements with hard-on-hard bearings. The incidence and functional impact of noise in association with ceramic-on-ceramic bearings may be higher than previously reported. The sound emitted by the bearing should be distinctively characterized in a proper sound environment. Two distinct types of sounds have been identified in our cohort: squeaking and knocking. Their cause and significance may vary and require further study. The use of hard-on-hard bearings offers many advantages in terms of wear reduction, especially for young and active patients. Nonetheless, patients considering ceramic-on-ceramic bearings should be counseled in regard of this phenomenon.

Poster: 218
#934

The Influence of Contact Area, Added Mass, and Added Stiffness on the Vibrational Behaviour of a Femur-Stem Structure

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The measurement of the stability of orthopaedic implants is a research topic for many years. Vibration analysis has been successfully applied in orthopaedics to determine bone mechanical properties, to monitor fracture healing, and to assess the stability of bone implants.

In the case of total hip replacement, the implanted stem influences the resonance frequencies of the femur in two ways mainly: the added mass determines a resonance frequency decrease, while the added stiffness implies a

resonance frequency increase.

To understand the influence of contact conditions at the bone-implant interface on the vibrational behaviour of the femur-implant structure, a finite element analysis was set up.

Using the CT scans of an artificial human femur and the STL files of a corresponding prosthesis, the geometries of the parts were created. Situations of partial contact were simulated by varying the contact tolerance option in the finite element software. Modal analyses on the hip stem–femur structure were performed in various contact situations.

Figure 1 presents the resonance frequency difference between the modes of the femur-stem structure at various contact situations and the correspondent modes of the femur without implant. It can be observed that the resonance frequencies corresponding to the first six modes of the system femur-implant are lower than the respective first six resonance frequencies of the femur, indicating that the influence of the added mass is more important than the influence of the added stiffness. Moreover, for these modes, the contact area increase results in relative small resonance frequency increase.

Starting with mode #9 the resonance frequencies of the femur-implant structure at 98% contact are always higher than the corresponding resonance frequencies of the femur, indicating a strong influence of the added stiffness.

Although the influence of the added stiffness is relatively important for the higher and complicated modes, the sensitivity to the size of contact surface is variable. For example, the mode #20 is very sensitive to the contact change. The frequency shift between 15% and 98% contact is 174 Hz and the mode shape of the femur is clearly influenced (see Figure 2). Such modes are very important for the assessment of the stability of the implant.

In conclusion, the results are in agreement with previous observations: contact increase causes positive resonance frequency shifts and, in general, the higher modes are more sensitive to the contact change.

The proportion between the influences of added mass and added stiffness is strongly dependent on the mode shapes of the femur-stem structure and on the amount of contact existing between the bone and the implant. This phenomenon can be understood from the fact that in the lower modes the prosthesis moves as a rigid body and only exerts an added mass effect whereas in the higher modes the interaction between the stem and the femur becomes more complicated and the interface conditions also affect the resonance frequencies.

Vibration analysis can be regarded as a very useful non-invasive tool in assessing the fixation stability of orthopaedic implants during and after surgery.

Figures

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Poster: 219
#436

Metaphyseal-Engaging Short Stem Femoral Implants: Five-Year Follow-Up

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Introduction:

While various uncemented femoral implants have demonstrated clinical success in total hip arthroplasty (THA), there are still a number of issues which remain to be addressed. These include the continuing problems of proximal-distal mismatch, optimized proximal load transfer, and facilitation of minimally invasive surgery. We present the five-year clinical and radiographic performance of a CT-based custom-made metaphyseal-engaging

short stem femoral implant.

Materials & Methods:

Between 2004 & 2005, 72 patients underwent 80 THAs with an uncemented metaphyseal-engaging short stem. After account for those deceased and lost to follow-up we present the clinical and radiographic results of 69 THAs. The implant was custom-made based on pre-operative CT to fit and fill the metaphysis. It was composed of a titanium alloy with a hydroxyapatite coating on a titanium plasma-spray in the proximal third of the stem. These patients averaged 61 years of age (range 22-79) and BMI of 28.9 (20.3 – 44.1) at follow-up.

Results:

Clinical performance was evaluated using the Harris Hip (HHS) and WOMAC scoring systems, both preoperatively and 5 years post-operatively. HHS averaged 55 (range 20 – 90) pre-operatively and 96 (range 55 – 100) post-operatively. WOMAC scores average 51 (range 13- 80) pre-operatively and 3 (0 – 35) post-operatively. No cases of subsidence were observed and no revision surgeries have been performed. Canal fill was good (> 84%) in all patients. Bone remodeling was typified by endosteal condensation and cortical hypertrophy in Gruen zones 2, 3, 5, and 6.

Discussion:

Overall, at five-year follow up the uncemented metaphyseal-engaging short stem is stable and exhibits proximal bone remodeling closer to the metaphysis than conventional stems in THA. Furthermore, this device has comparable clinical performance as previously evaluated conventional and off-the-shelf short stem implants. Although, we have no revisions to report, theoretical bone preservation from a proximally loaded femur remains a potential advantage to this design.

Poster: 220
#646

A Mid-Term Comparison of Off-the-Shelf & Custom Short Stem Metaphyseal Femoral Implants

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Introduction:

Short stem metaphyseal engaging femoral implants provide theoretical benefits compared to uncemented stems of conventional length. These include: 1) avoidance of proximal-distal mismatch; 2) decreased proximal stress shielding and; 3) reduction in peri-operative peri-prosthetic fractures. This study compares the minimum four-year clinical and radiographic results obtained with an off-the-shelf metaphyseal filling short stem to the five-year follow-up data obtained with a custom-made short stem implant.

Methods:

A prospective evaluation of 51 hips in 50 patients treated with an uncemented metaphyseal engaging short (91-105mm) stem with minimum 48 month follow-up was performed. The average age of patients in the study group at follow-up was 71 years (range: 32-95) with an average BMI of 28 (range: 19-42). The control group consisted of 69 THAs with CT-based custom-made short stem implants. These patients averaged 61 years of age (range: 22-79) and BMI of 28.9 (range: 20.3-44.1) at follow-up.

Results:

In the off-the-shelf short stem group the average Harris hip score (HHS) was 51(range:10-70) pre-operatively and 91(range:70-100) post-operatively; pre-operative WOMAC scores averaged 49 (range:9-91), compared to a post-operative average of 6 (range:0-25). No patients had thigh pain. All stems were radiographically stable with proximal bony in-growth. In the control group with custom short stems, the HHS averaged 55 (range:20-90) pre-operatively and 96 (range:55-100) post-operatively; WOMAC scores average 51 (range 13- 80) pre-operatively and 3 (0 – 35) post-operatively. There was no difference in post-operative pain or function scores between the two

groups (two-sample t(179 df)=0.667, p=0.506).

Discussion & Conclusion:

This study confirms that an off-the-shelf short femoral stem designed to fit and fill the metaphysis provides as reliable fixation and function at a minimum four-year follow-up as a short stem custom implant designed to maximize metaphyseal contact.

Poster: 221
#891

Single Use Instrumentation Increases Efficiency in Primary Navigated Total Knee Arthroplasty

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Summary:

Single-use instruments showed increased efficiency in patient OR time, surgical episode time, anesthesia, and tourniquet time.

Introduction:

Under the current healthcare climate, continuous improvements are being made to enhance operating room efficiency. The purpose of this study was to determine the effect of traditional instrumentation vs. single use instrumentation (SUI) on OR efficiency in navigated TKA procedure by a single surgeon at a community hospital.

Methods:

This is a prospective, randomized trial at a single center, community hospital. All surgeries were performed by a single surgeon using navigation. Patients were split into two groups: Group 1(Navigated Traditional) and Group 2(Navigated SUI). A total of subjects enrolled were Group1 (n= 24) and Group2 (n=25). Efficiency was examined by measuring specific time intervals based on milestones in the OR preparation, surgical procedure, OR cleanup, instrument clean-up, surgical episode, regional anesthesia, tourniquet, and OR turnover.

Results:

Instrument set-up time was reduced by an average of 1.6 minute (min) in Group2 vs. Group1 (p=0.42). Patient set up was similar in both groups (p=0.10). For procedure time, Group2 had significant (p=0.00) decrease of 4.90 min vs.Group 1. Group2 had significant (p=0.01) decrease of 7.96 min vs.Group 1 for patient OR time. Instrument clean up time was significantly (p=0.00) decreased by 6.78 min in Group2 vs.Group1. Overall surgical episode was significantly (p=0.00) decreased by 13.23min in Group2 vs. Group1. Regional anesthesia (mean difference 17.98 min (p=0.007) and tourniquet time (mean difference 5.32 min (p=0.010)) were statistically reduced in Group2 vs.Group 1. Group2 had a notable reduction in overall instrument set-up and clean-up time by 8.38 min vs. Group1.

Conclusion:

Single-use instruments showed increased efficiency in patient OR time, surgical episode time, anesthesia, and tourniquet time. A larger prospective trial is warranted.

Poster: 222
#861

Post-Cam Contact Mechanics During Several Activities in Primary and Revision TKA Designs: A Numerical Study

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Introduction

Posterior Stabilized (PS) Total Knee Arthroplasty (TKA) designs were introduced to compensate for the resected or deficient posterior cruciate ligament and to avoid paradoxical roll-forward of the femur [1]. Despite good functional long term results, concern may rise about post-cam stresses and either post-cam failure or transmission of these stresses to the modular and bone-implant interfaces. This can induce backside wear of the tibial insert and loosening of the tibial baseplate.

The aim of our in-vitro study is to estimate the contact mechanics in the post-cam mechanism during several activities in primary and revision PS TKA designs.

Material and Methods

CT images of one cadaveric full leg were used to generate 3D models of the bones using Mimics (Materialise, Leuven, BE) and to obtain a physiological knee model assuming positions of the main soft tissue insertions, from CT images analysis and as described in literature [2-3]. Two PS primary TKAs (Genesis II and Legion (Smith&Nephew, Memphis, TN)), with conventional polyethylene insert, and the respective revision types, with condylar constrained polyethylene inserts, were chosen for this study. All prostheses were the same size and all resurfaced the patella. Each TKA was virtually implanted according to the proper surgical technique.

The following motor tasks were analyzed: walking, stair descent, stair ascent and squat. Gait analysis, experimental tests on cadaver legs and literature studies were used to define the boundary conditions for each movement. The loaded movements were numerically reproduced, simulating existing knee kinematics rigs in terms of geometries, constraints, inputs and outputs.

A validated muscolo-skeletal model [4], using LifeMOD/KneeSIM 2007.1.3 (LifeModeler Inc., San Clemente, CA), was used to evaluate, for each model and movement, the post-cam contact force (PCF) as a function of flexion angle.

Results:

All designs, and motions, showed a gradual increase in contact force on the post during flexion from the point of initial post-cam engagement.

Figure 1 shows the maximum value of the contact forces for different movements for each TKA.

Different motor tasks show a different value of maximum post-cam contact force. The values are similar among different TKAs with a slightly higher contact force (on average from 3% to 5%) in the revision design compared to the corresponding primary design. For all the designs and motions, the maximum PCF always occurred close to the maximal flexion angle (walking 65° stair descent 68°, stair ascent 93°, squat 120°).

Conclusions:

The aim of our work was to estimate the maximum contact forces in the post-cam mechanism for several activities in primary and revision PS TKA.

Even if the values are similar among different designs, different motor tasks show a different value of maximum PCF. A slightly higher force is observed in the revision with respect to the corresponding primary design.

These results are in agreement with data shown in literature [5] and outcomes from experimental tests [1-4].

References:

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LaPrade et al., AJSM, 2004;

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Figures

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Figure 2

Poster: 223

#1100

Acetabular Cup Stability: The Effect of Incorrect Reaming on Three Acetabular Cup Designs

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BACKGROUND

The acetabular cup primary stability is an essential requirement to promote bone ingrowth, therefore obtaining long-term implant stability. The amount of bone ingrowth for acetabular components is determined by initial stability or press-fit: an oversized cup impacted into a properly prepared acetabulum makes use of the bone visco-elastic properties to allow deformation and recoil, thus gripping firmly the implant [Cameron et al., 1973; Curtis et al., 1992].

The AIM OF THE STUDY is to investigate press-fit properties of three different WMT cup designs, simulating correct and shallow acetabular preparation

METHODS

Three acetabular cups (*Figure 1*) have been used in order to investigate their press-fit properties:

ANCA-FIT ™ , (OD) Ø = 54 mm,→ hemispherical press-fit

PROCOTYL ® L OD: Ø = 52 mm,→ equatorial press-fit

EHS-E OD: Ø = 52 mm, → equatorial press-fit

A specific test has been chosen to *in vitro* quantify the cups' Press-Fit: the Axial Stability Test [Baleani et al, 2001]. The acetabular cups were impacted in the 20 pcf (0.24 g/cc) polyurethane foam (Sawbones ®) using the MTS 858 MiniBionix testing machine and applying a compressive load of 2000 N. For each axial stability test, a pure torque moment was applied at a rate of 1 Nm/s, while a compressive load of 50 N was held on the acetabular cup. The same testing protocol was used for two surgical technique simulations:

CORRECT REAMING : the cavities were created according to product specific surgical technique;

SHALLOW REAMING : a reaming depth 3 mm less than the nominal one.

The peak torque moments were recorded. Afterwards, the model was validated by comparing the results with the ones proposed in the Scientific Literature [Baleani et al., 2001] and a t-test analysis was performed.

RESULTS

The obtained results are summarized in *Figure 2*. A typical torque moment - degree plot is also reported.

The ANCA-FIT™ nominal reaming results (19772 Nmm ± 3029 Nmm) are compared with the results obtained for the same configuration adopted by Baleani et al. (18600 Nmm ± 2120 Nmm), thus validating the experimental protocol.

Statistical Analyses (T-test, $p<0.05$) show that the maximum torque moment reached in the optimal configuration is not statistically significantly different by comparing the three acetabular cups, but also that a reaming error significantly affects the PROCOTYL ® L and EHS-E press-fit properties (T-test, $p<0.01$).

CLINICAL RELEVANCE

The obtained data point out that surgical errors during the reaming phase could produce press-fit mechanical consequences depending on the acetabular cups involved:

There is no difference amongst the Wright evaluated cups in terms of press-fit generated, if implanted with a correct technique. A surgical reaming error produces a reduction of press-fit for EHS–E and PROCOTYL ® L cups. In contrast, the ANCA-FIT ™ cup doesn't seat perfectly within the reamed cavity and the cup's rim stays proud.

The ANCA-FIT ™ cup's primary stability is not jeopardized by a 3 mm shallow reaming (in terms of maximum torque moment);this mechanical outcome is due to the different ways the cups generate press-fit.

Figures

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Figure 1 HYPERLINK "http://app.istaonline.org/figures/1654.jpg" \t "_blank"
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Figure 2

Poster: 224
#579

A Novel Femoral Stem Design for Use in Patients With High Canal Flare Indices During Total Hip Arthroplasty.

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Introduction

Short femoral stems have gained interest as an alternative to traditional femoral stems and hip resurfacing. Potential advantages include bone conservation and improved physiologic loading. Different designs have met with mixed results. We describe the initial experience of a single surgeon with a short tapered wedge stem released in March 2008 (TriLock BPS, Depuy Orthopaedics, Warsaw, IN) in a young population with a high canal flare index (CFI).

Methods

12 patients average age of 38 (25-48) and average CFI 4.51 (3.36-5.66) had a short tapered wedge stem implanted by a single fellowship trained surgeon between July 2008 and March 2009. Patients were selected based on age, bone quality, and CFI. CFI was measured as the ratio of the intracortical width at 2 cm proximal to the lesser trochanter to the width at the isthmus of the femoral canal [1]. Patients were assessed with standard AP and lateral radiographs and templated with both standard and short femoral stem lengths, with short stem demonstrating better fit. At minimum 2-year follow-up, radiographs were assessed by a blinded observer for bone ingrowth, subsidence, and aseptic loosening. Patients completed a Short Form-36 (SF-36) and Harris Hip questionnaire with a clinical exam performed by a surgeon fellowship trained in arthroplasty.

Results

10 patients were available for follow-up at an average of 29 months (24-33). Radiographically, all 12 hips demonstrated excellent bone ingrowth at 4 months, which continued in the 10 radiographs available for follow up at minimum 24 months. All stems were still placed in the neutral position with no subsidence, nor any signs of aseptic loosening. Average Harris Hip and SF-36 scores for all patients were 86 (62-100) and 76 (53-91) respectively.

Conclusions

The use of a short tapered metaphyseal wedge stem is an alternative option in young patients with champagne flute femoral canals. Our initial results demonstrate good clinical and excellent radiographic results at a minimum 2

years follow up [2]. Potential advantages include more physiologic bone loading, bone conservation, and avoiding the need to ream a tight diaphyseal canal that may be encountered with other designs and stem lengths. Longer follow up with larger series are warranted.

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Poster: 225
#700

Cement-Bone Interface and Reamer Geometry as Critical in Cracks Initiation, an in Vitro Long-Term Failure Risk of a Stanmore Hip

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Introduction

The use of cemented hip prostheses has given excellent clinical results, and THR is at that moment one of the most successful surgical techniques in orthopaedics. Failure can occur in the short–term and can be related with the geometry of the stem and skill of the surgeon. Other factors are type of cement, surface finish and cement-mantle thickness and have been correlated with long term failure scenarios. The aim of this study was to verify the in vitro behaviour a commercial Stanmore cemented femoral stem relatively to fatigue crack formation.

Materials and Methods

Four in vitro femoral cemented hip replacements were performed using synthetic femurs (large left femur, mod. 3310). The arthoplasties were loaded and tested in stair climbing fatigue loading during one million cycles at 2Hz. The load was applied with the femur positioned at 11º on frontal plane and 9º on the sagital plane, as specified by the ISO 7206 standard. After the in vitro fatigue tests each implanted synthetic femur was sectioned at same position in eleven sections. The sections were analyzed with a non destructive technique to detect the crack formation and debonding in cement bone interfaces.

Results

A first visual inspection of the specimens showed different type of surgical defects, namely significant voids on the cement mantle and an incorrect-positioning of the stem. We observed more damage (cracks per area) on the proximal part of the cement mantle. The micro cracking formation initiated preferably in the bone-cement interface. The maximum crack length measured was 1,01 mm on section S10 (distal region) and began at cement-stem interface and 1.33 mm on section S5 at the bone-cement interface. The [Fig 1] shows cracks and debonding in some sections. The visualization of 3D cracks revealed small cracks on the proximally regions with low cement thickness, and in the cement bone interface.

Discussion

The analysis of the crack density or the accumulated damage showed that it depends on the axial position, and increases distally to proximally region. We observe the crack length was critical in section S5 (ISO 7206) on bone-cement interface. An increase of cement thickness decrease the cracks length, this phenomenon was verified on the distal parte. Within the observation of the cracks it is possible to see the influence of the reamer geometry on the cement-bone interface. But when the interface was cement-cortical bone we observe a different situation, because the geometry of canal was defined by geometry of cortical bone and was very well defined.

Conclusions

This study showed that the bone-cement interface is crucial for the initiation of the damage mechanism at proximal region. The cement mantle thickness and geometry of reamer determines the interface where the crack begins. The procedure of the femoral canal reaming is not only important to define the position of the stem, but also to define

the geometry of cement mantle. Even though, the results of this study show that damage of the cement mantle has influence of stem geometry.

Figures

Poster: 226
#1115

A Novel Cemented Hip Femoral Stem Concept

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The development of a new cemented hip prosthesis is certainly a very hard task if aiming the improvement of actual performance.

This study presents a methodology applied to develop a novel hip stem concept which was based on the comparison of the performance of the best cemented stems actually in the market.

Realistic numerical models also allowed us to determine cement mantle stresses of commercial femoral stems that were compared with those obtained for the new concept stem.

Fatigue tests were also performed to determine the density of cracks in the cement mantles, as well as debonding. The new model was then prototyped and tested through in vitro fatigue tests.

The new hip presents an innovative collar, "organic" geometry sections and reduces the cement stresses in an average of 25% relatively to the commercial stems used in the study.

Poster: 227
#475

Acetabular Reconstruction in Severe Bone Defects Using a New Cup With Iliac Screw: Results After 3 Years

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INTRODUCTION:

Since July 2008 we are experimenting a new cup with iliac screw fixation, developed on the idea of Ring and Mc Minn. Iliac fixation is permitted by a polar screw of large diameter, coated by HA, which allows a compression to bone and a firm primary stability. Moreover it's possible to increase primary stability with further smaller peripherals screws. We present this new cup and report the preliminary results.

MATERIALS AND METHOD:

Since July 2008 to December 2010, 60 cups were implanted. The diagnosis was aseptic loosening in 41 cases, septic loosening treated by two-stage revision in 7, hip congenital dislocation in 6, one case of post-traumatic osteoarthritis, one case of pelvic disjunction, 2 cases of instability due to cup malposition and 2 cases were an outcome of Girdlestone resection arthroplasty. Mean age was of 67 years (29-90).

RESULTS:

We report the results of our first 48 cases, with a minimal follow-up of 12 months. Patients were preoperatively evaluated from both clinical and radiological point of view. Bone defect was analyzed according to the system of Paprosky. In 21 cases bone defect belonged to type 2C, in 15 cases to type 3A and in 12 cases to type 3B. We didn't observe any case of early loosening nor mechanical failure of the implant. The functional outcome, evaluated by Harris Hip Score, was good with a mean score of 81 (69-91).

Poster: 228
#886

Bone Colonization Evaluation for EBM Additive Manufactured Ti Porous Structures Through in-Vivo Investigations and FEM Analysis

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Introduction:

Since a couple of decades technology has permitted to build up 3D solid parts overlapping numbers of micrometric layers representing the specific section of the piece for each level. All the different technologies able to realize components according to this strategy are grouped under the name of Additive Manufacturing (AM). In recent years AM was extended at implantable materials such as titanium and titanium alloy (Ti6Al4V), metals which are widely used in the orthopaedic prostheses field. The main advantage with AM is design freedom as it allows manufacturing of complex shape – complex surface components in a cost-timing competitive manner. One of the most appreciated features enabled by AM is design and nearly one step production of orthopedic components with surface trabecular structures suitable for bone colonization and enhanced device fixation.

Aim of the work:

Several in-vivo tests were performed to qualify and quantify bone ingrowth into several titanium foams supplied in geometrical repeated sequences, with and without post treatments. Correlate data collected in a predictive Finite Element Model (FEM).

Materials and Methods:

Geometrical ordered porous structures made of Titanium alloy (Ti6Al4V) were built using Electron Beam AM technology. Pores and struts have dimensions in the hundreds micron range. Implantations were performed in goats and healing process was followed for several weeks. At explantation it was investigated: bone penetration depth, bone to metal porous structure fixation strength, health and quality of new formed tissues into and around metal pores.

Same parameters were also evaluated when additional post treatments as hydroxyapatite (HA) coatings or chemical etching are further applied to AM porous networks.

A FEM was developed to predict bone-implant fixation strength by changing critical parameters as: titanium foam geometry, post treatment of the foam (HA or not HA), bone ingrowth depth and bone density (cancellous or cortical).

Results:

In-vivo results showed excellent biocompatibility and bone ingrowth potential for most of the geometrical porous structures manufactured without additional post treatments. However potentially risky conditions have been detected for some specific porous structures pointing out the critical importance of residual metal beads removal from inner pores surface (Fig.1).

In some topographic structure particularly intricate additional post treatments as chemical etching can be effective for metal beads removal from inner pores surface. Etching was showed not impairing the bone colonization of the porous structure.

Addition of a plasma spray HA coating (Osprovit®) on the surface of an AM titanium porous structure increases bone ingrowth depth and accelerates its colonization (Fig.2). HA coating showed also a significant effect in enhancing bone implant contact at explantation time (6 weeks).

FEM analysis showed that metal-bone interface strength depends on the bone ingrowth depth and surface treatment. Up to a certain bone ingrowth depth, different for the coated and uncoated interfaces, increasing bone ingrowth depth caused an increase in interface strength. Coated interfaces yielded greater interface strength than uncoated. These results were consistent for models with cortical and cancellous bone (Fig.3).

Acknowledgements:

This study was cosponsored by Provincia Autonoma di Trento and Eurocoating SpA, Trento, Italy.

Figures

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Figure 6

Poster: 229
#413

A Novel Method to Quantify Asymmetry of the Resected Surface of the Proximal Tibia in Total Knee Arthroplasty

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Introduction:

One of the challenges in performing total knee arthroplasty (TKA) is correct alignment of the tibial tray on the resected surface of the proximal tibia (RSPT). This is exacerbated by the use of symmetric trays on an asymmetric bony surface. The asymmetry of RSPT is generally recognized, however after our review of the available literature we were not able to identify a reproducible method to quantify the magnitude of the asymmetry.

Materials and methods:

18 (9 male and 9 female) cadaveric non-pathologic tibia were digitally reconstructed from CT scan data. Using a technique that we developed, the medial-lateral (ML) axis of each RSPT, perpendicular to the tibial shaft axis, at the level 9mm distal to the lowest point of the tibial plateau was established and measured. The ML axis was divided into equal medial and lateral segments. The anterio-posterial (AP) depth of both the medial (APM) and lateral (APL) plateaus were measured perpendicularly to the ML axis through the middle of the medial and lateral segments of the axis. To quantify the asymmetry of the plateau, APM/APL ratios were calculated for all of the specimens. The data was analyzed for the group as a whole and for male only and female only subgroups. T-tests and chi-square tests were used to assess the p-values.

The average ML width of all the specimens was 74.6 mm. The average difference in AP depth of the medial and lateral quadrants was 2.8mm (APM: 47.9±5.59 mm APL 45.1±5.11 mm; $p<0.001$), with an APM/APL ratio of 1.06 ($p=0.0002$). There was no statistically significant difference between the degree of asymmetry in males and females (APM/APL ratios: 1.07 males: vs. 1.05; $p=0.14$)

Conclusion:

The study describes a new method for quantifying the asymmetry of the resected surface of the proximal tibia in TKA. Our data demonstrated consistent asymmetry for all of the specimens studied. Statistically significant gender differences in asymmetry of the tibial plateaus could not be demonstrated.

Poster: 230
#805

8 Year Followup After a 1 Open 3-Part Humeral Head Fracture With Head Splitting at the Dominant Upper Limb

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We present the case of a then 17 year old patient with a heavily dislocated 3-part fracture of the humeral head

(head splitting) with perforation of the rotatory cuff and deltoid muscle (1° open fracture) and lesion of the axillary nerve of the right shoulder that was caused by a car accident. [Fig. 1]

In the emergency room the wound was closed after extensive cleaning and a treatment with a hanging cast was started. Upon admission to the hospital there was already a sensory-motor lesion of the axillary nerve present, which didn't cease after the swelling had diminished.

6 days later the operation was performed: open reduction and osteosynthesis with screws and a 6 hole one-third tubular plate using a deltopectoral approach.
The humeral shaft fragment had caused a defect (about 4 x 4 cm) in the deltoid muscle and supraspinatus tendon by perforation. The ventral part of the humeral head with the minor tubercule was subluxated and flexed, so the subscapular tendon had to be removed in order to achieve a good reduction. The two head parts were fixed with 2 screws, then a 6 hole one-third tubular plate was fixed to the shaft above the greater tubercule. The reposition had to be left in a slight varus inclination. Finally, the split supraspinatus tendon was fixed with Syntofil and Vicryl sutures and the subscapularis tendon was reattached with 2 Mitek G II anchors. [Fig. 2]

10 days later physiotherapy was started with passive oscillating movements, 6 weeks after the surgery with active movements and weight bearing.

6 weeks after the operation the patient reported almost no pain, but there was an atrophy of the deltoid muscle and a subluxation of the humeral head due to the lesion of the axillary nerve. The motory innervation of the deltoid was intact, making the active centralisation of the humeral head possible. The hyposensibility in the dermatome of the axillary nerve was persistent.

After intense exercise and muscle training, after 3 months a complete regression of the subluxation of the humeral head was seen. There was a persistent hypotrophy of the infra- und supraspinatus muscles with normal sensory-motor function, but minimally diminished strength in abduction. The range of motion was almost normal, leaving just a slight impairment in elevation and abduction of 5°. The fracture was healed. [Fig. 3]

5 months after the operation he had returned to work as a window installer (heavy overhead work).

About 18 months postoperatively, a shoulder arthroscopy and open removal of the osteosynthesis materials was performed. The biceps, subscapular and supraspinatus tendons appeared normal. Connective tissue was found on the glenoid and partly on the humeral head, due to remodelling processes.

About 2 years later the patient presented with an exostosis at the site of the former Mitek anchor insertion on the minor tubercule which was painful when pressure was applied directly upon it. In accordance with the patient, no further operative interventions for exostosis removal were initiated. During the follow-up the patient was almost asymptomatic**.**

Figures

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Figure 6

Poster: 231
#580

Treatment of Pelvic Bone Tumors: Resection and Reconstruction of 129 Cases

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Introduction:

Surgery of pelvic sarcomas shows higher rates of local recurrence and complications and a lower functional outcome than other localizations. According to the different types of pelvic resections and therefore the need of different reconstructive methods, the goals of surgery include local control and maintenance of good quality of life.

Objectives:

Purposes of this study was to present the outcome of limb salvage surgery with reconstruction for bone pelvic tumors.

Methods:

From 1990 to 2010, 231 patients with pelvic bone tumors were treated by surgical resection. Three patients were excluded due to lack of data and 99 cases were excluded because reconstruction was not performed. The remaining 129 were followed at a mean of 6 years (range 1-19 years). Histologically there were 79 chondrosarcomas, 18 Ewing's sarcomas, 18 osteosarcomas, 4 giant cell tumors, 3 spindle cell sarcomas, 3 metastatic tumors, 2 fibrosarcomas, 1 angiosarcoma and 1 desmoplastic fibroma. According to Enneking's classification, 23 patients had type I (ilium), 21 type II (periacetabular) and 1 type III (anterior arch) pelvic resection. Combined resections were performed in 23 cases (type I-II), 40 cases (type II-III), 14 cases (type I-II-III) and 7 cases (type I-IV). In 31 cases there was no acetabular involvement and reconstruction was performed with allograft only (23 type I resections, 7 type I-IV, 1 type III). Acetabular resections were reconstructed with prosthetic composite allografts in 64 cases (27 with conventional prosthesis, 34 stemmed pelvic prosthesis, trabecular metal in 3 cases), with allograft only in 11 cases, with prosthesis only in 10 cases, with saddle prosthesis in 12 cases and arthrodesis in one case.

Results:

Margins were wide in 94 cases, wide but contaminated in 22 cases, marginal in 7 cases, intralesional in 6 cases. Oncologic outcome showed 73 patients continuously disease free, 6 NED after treatment of relapse (3 with local recurrence, 1 with metastases and 2 with both), 16 alive with disease, 29 died of disease and 5 dead of other causes.Survival was 74% and 65% at 5 and 10 years respectively (figure 1). Incidence of local recurrences was 21.7% (28 patients). Survival to local recurrence was 76% and73% at 5 and 10 years, respectively (figure 2). Local recurrence occurred in 20% of wide margins and 26% of inadequate margins (p=0.353); it involved the periacetabular area resections in 22 cases out of 98 cases (22.4%) and other sites of resection in 6 cases (19.4%) (p=0.839). The incidence of metastases was 27.1% (35 patients).Deep infection was the most common complication, observed in 27 cases (20.9%) at a mean follow up of 11 months. No statistical difference was found between reconstructions with and without allograft (p=0.257). In 14 cases a final external hemipelvectomy was performed due to local recurrence or infection (10.8%). Average MSTS score was 68.3%.

Conclusions:

Favourable oncologic and functional outcome can be achieved in selected patients with pelvic bone tumors. Infection is a major complication requiring further surgery. The use of allografts does not increase risk of infection. External hemipelvectomy is rarely needed for recurrence or infection.

Figures

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Figure 2

Poster: 232
#583

Distal Femur Reconstructions With Modular Prostheses: The Rizzoli Experience.

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Introduction:

Distal femur is a common site for primary and metastatic bone tumors. Although a variety of reconstructive options have been described, endoprosthetic replacement is used most commonly with good implant survival.

Objectives:

Our aim was to evaluate the incidence of complication in distal femur megaprosthetic reconstructions after resection of distal femur tumor with modular prostheses and to perform a comparative statistical analysis of fixed and rotating hinge knee prostheses.

Methods:

A retrospective analysis was performed of implant survival, complications and functional results assessed according to MSTS system of the Rizzoli series of distal femur modular megaprostheses. Between 1983 and 2010, 687 modular prostheses were implanted after resection of distal femur tumor: 380 were males and 307 were females with a mean age of 36 years. In 491 cases fixed hinge knee prostheses were implanted and in 196 cases rotating hinge knee prostheses. Type of prostheses included: 93 KMFTR, 398 HMRS, 196 GMRS. Histologic diagnoses included: 427 osteosarcoma, 27 Ewing sarcoma, 43 chondrosarcoma, 25 metastasis, 71 GCT, 30 MFH, 52 other sarcomas and 12 non oncologic cases. Major complications were analyzed and statistical evaluation with Kaplan Meier curves and comparative statistical analysis with Log rank test were performed.

Results:

Oncologic outcome in 662 evaluated oncologic pts, showed: 364 pts continuously NED, 90 NED after treatment of relapse, 17 AWD, 191 DWD. Complications causing implant failure occurred in 116/687 (16.8%) cases. Infection occurred in 57/687 patients (8.3%), aseptic loosening in 33/687 patients (4.8%), breakage of prosthetic components in 26/687 patients (3.8%). Implant survival to all major complications was 80% at 10 years and 60% at 20 years (Figure 1). Infection occurred in 44/491 (8.9%) fixed hinge knee prostheses and in 13/196 (6.6%) rotating hinge knee prostheses with no significant difference in implant survival to infection between fixed and rotating hinge knee prostheses (p=0.2370).Aseptic loosening occurred in 29/491 (5.9%) fixed hinge knee prostheses and in 4/196 (2%) rotating hinge knee prostheses with no statistically significant difference in implant survival to aseptic loosening between fixed and rotating hinge knee prostheses (p=0.5503).Breakage occurred in 26/491 (5.3%) fixed hinge knee prostheses, while no cases of breakage were observed in rotating hinge knee prostheses.There is no significant difference in implant survival to all major complications between fixed and rotating hinge knee prostheses (p=0.4473) (Figure 2).Functional results, evaluated in 536 pts, were satisfactory in 91.4% (490/536) cases with a mean score of 23.3.

Conclusions:

Most frequent cause of failure was infection. Implant survival at long term was quite satisfactory. There was no significant difference in implant survival between fixed and rotating hinge knee prosthesis. Functional results were good or excellent in most cases.

Figures

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Figure 2

Poster: 233
#745

Avascular Necrosis of Bone and Drug Abuse

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We reviewed our case of AVN of different part of body since 2005.We noticed increasing number of AVN espesialy in un usual part of musculoskeletal system with history of Drug Abuse especially Bupinorphine.

According to united nation investigations Iran is one of the leading consumers of drug abuse in world.

In this lecture I want to present a summary of our experience about unusual cases of avascular necrosis after drug abuse in different part of body.

Increasing number of these cases in our country caused drug abuse to be the leading cause of avascular necrosis in unusual bone like around knee and clavicle and probably the most common cause in hip joint.

Some of the patient has had the history of IV dug abuse especially with some trademark of methadone .the pattern of radiology with x-ray or MRI

Is not unique and sometimes not similar to other cases of AVN . There is also some difference in gross pathology and microscopic findings.

Core decompression with or without bone graft has been effective in some cases but there are some especial problems with anesthesia for these patients.

Figures

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Figure 2

Poster: 234

#585

Cementless THA Using Custom-Made Femoral Components in Patients With Developmental Dysplasia of the Hip. Minimum 10 Year Follow-Up Study.

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INTRODUCTION:

Although 125-130 mm custom-made femoral components with blasted surface (first generation) provided favorable results in patients with developmental dysplasia of the hip, the intraoperative technical errors did not lead to bone ongrown fixation (CORR 2006). In order to reduce technical errors, we have changed the design concept

of the femoral component since 1997. The purpose of this study is to evaluate the clinical and radiographic outcome of patients who underwent second generation custom-made cementless THA.

METHODS:

Between November 1997 and May 2001, 136 primary cementless custom-made THAs were performed in 106 patients with secondary osteoarthritis and reviewed at mean 135 months follow-up (range: 120 - 157 months). There were 72 hips for Crowe I, 47 hips for Crowe II, and 17 hips for Crowe III. Five patients had a previous femoral osteotomy. There were 101 females and five males. The mean age at operation was 53 years (32 - 70 years). Custom-made, 90-100 mm-long, Ti-6Al-4V femoral components with proximal plasma-spray coating and distal sand-blasted surface were fabricated based on the computerized tomography.

RESULTS:

The mean Harris hip score improved from 48 (range; 15-64 points) before the surgery to 98 points (range; 80-100 points) at the latest follw-up. 131 patients (96 %) had more than 90 points for total score, and none had thigh pain at the latest follow-up. Radiographically, all 136 hips (100%) showed obviously extensive bone ongrowth onto the middle part of the stem. There was no aseptic loosening. At 1 cm below the lesser trochanter level, the mean canal filling on the anteroposterior view was 92.9 % and the mean filling on the lateral view was 91.8 %. At 1 cm above the stem tip level, the corresponding values were 84.6 % and 81.7 %. Proximal stress shielding was detected in 97 hips (71%).

DISCUSSION AND CONCLUSION:

Cementless THA has been advocated to enhance fit and fill of variable hip geometry. A 90-100mm femoral component improved the feasibility of stem insertion and the distal fill. The second generation custom-made femoral components provided better results in Crowe I, II, and III hips.

Poster: 235
#488

Role of Geometrical Features on Torsional Stability of Hip Stems

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Introduction

The most common complication related to cementless stems is loosening; thus achieving good primary fixation of cementless stems is essential, ensuring the success of hip replacements [1]. There are many factors that affect the axial and torsional stability of the stem, namely, stem geometry and material, type and extent of porous level, and fit and fill conditions [2]. Any geometrical feature that could potentially increase the stability of the stem would be helpful to reduce the possibility of micromotion, thus creating an environment for good bone/implant osteo-integration. This study looks at the effect of tapered fins below the porous coating level to determine whether or not this feature contributes to the torsional stability of two very similar stems.

Materials and Methods

The cementless stem A and stem B are similar in size and geometry above the porous coating level. The geometry of stem A includes three tapered fins, as shown in Figure 1 (left). The geometry of stem B includes medial/lateral mid-plane vertices extending from the porous level to the distal end of the stem, shown in Figure 1 (right). Approximately 2.0" (50.8 mm) of the length of each stem measured below the porous coating level was isolated for this study using saw bones.

All saw bones (n=10) were transversely sectioned at two levels, 2.0" and 9.0" (50.8 and 229.0 mm) below the calcar region, creating three sections (proximal-, mid-, and distal-section). Each of the selected mid-sections of saw bones was individually placed in the MTS Alliance RF/150 elctromechanical loading machine, and the stems were press fitted with a continuously increasing load at a rate of 0.10" (2.54 mm) per minute using the proximal A/P hole. The compressive load was stopped at 200 lbf. (890 N). Then each stem-bone assembly was placed in a cylindrical metal fixture and secured with a two part epoxy FAST-CAST and placed in a biaxial loading frame while applying a constant torque at a rate of 5 degrees per minute.

Results and Discussion

Based on the saw bone selection, 200 lbf. (890 N) insertion force and the rate in which the compression and torsional load were applied, the average maximum torque values for stem A and stem B were 53 ± 2.5 and 30 ±

5.5 in-lbf (5.990 ± 0.283 and 3.390 ± 0.622 N-m), respectively. Stem A showed an approximately 40% higher torque resistance value, which is significant ($p<0.007$) as compared with that of stem B, as shown in Figure 2. This higher torque value resulted from the addition of tapered fins below the porous coating level. It is well understood that the bulk of rotational stability of stems is due to their proximal geometry, however, addition of the tapered fins below the porous coating level may offer added measureable torsional stability when it is needed during daily activities (especially chair rising), helping to reduce micro-motion, thus potentially supporting a good primary fixation. .

References

1. Abdul-Kadir, M.R. et al. Journal of Biomechanics 41 (2008) 587–594

2. Viceconti, M. et al. Journal of Biomechanics 39 (2006) 1169–1179

Figure 1. Enlarged view of hip stem A (left) and stem B (right) bodies below the porous coating levels

Figure 2. Averaged maximum torque values (in-lbf) for stem A (left) and stem B (right)

Figures

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Figure 2

Poster: 236
#760

Three Dimensional Hip Anatomy in Anterior Dislocation After Tha. Influence of the Hip Rotation Center Position

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INTRODUCTION

The components position is a major factor under the surgeon's control in determining the risk of dislocation post THA. Most of the report into this subject have evaluated the components position using radiographs, and focused on the cup anteversion and inclination.

However, radiographs do not provide an accurate measurement since conventional radiography is highly dependent upon the position of the patient on the imaging table. Furthermore, some measurements such as the 3D coordinates of the hip center of rotation (COR) or the stem anteversion, cannot be determined on conventional X-rays.

The proper three dimensional (3D) position of the hip center of rotation has never been analyzed in a cohort of patients who experienced anterior dislocation post THA using a direct anterior approach. The aim of the study was to analyze the correlation between the 3D position of the hip COR and the anterior dislocation risk.

METHODS

Among 1764 consecutive patients who underwent THA using a direct anterior approach, 27 experienced anterior dislocation. The 3D hip anatomy was investigated using HIP-PLAN® software in 12 patients who were paired with 12 patients from the same initial cohort who did not experience dislocation and also with 36 control patients with primary osteoarthritis who did not undergo THA. The COR coordinates were expressed as percentages of the pelvic width (PW), height (PH) and depth (PD). The anteversion angles were measured.

RESULTS

The hip COR was significantly shifted medially and posteriorly in the dislocation group when compared to the non-dislocation group ($p=0.0008$) and also to the control group (Figure 1). The mean femoral anteversion angle was significantly increased in the dislocation group compared to the natural control group ($28.3 \pm 11.5°$ versus $22.9 \pm 8.5°$, $p<0.04$). By contrast, there was no significant difference between the non-dislocation group and the control group regarding the anteversion angles.

DISCUSSION

The main finding of this study was that anterior dislocation post THA correlated to a poor restoration of the hip COR which was shifted medially and posteriorly. These results suggest the importance of an accurate COR restoration, whilst avoiding an excessive acetabular reaming which may induce a medial and a posterior translocation. When using cementless components, this COR medialisation may be imposed in some patients with an acetabular dysplasia, in order to obtain a good mechanical anchorage of the acetabular cup.

To our best knowledge, this is the first reported study that proves a correlation between the three dimensional COR position and dislocation rate. The authors postulate that this was related to a medial lateral and an antero-posterior laxity which may lead to dislocation especially if the femoral anteversion is increased in comparison to the natural preoperative value. This medial lateral laxity may also generate edge loading which was incriminated in specific complications of hard-on-hard bearing surfaces such as friction deterioration, stripe wear, increased wear rates, ceramic fractures and squeaking.

Figures

Poster: 237
#744

Accuracy of Billing Codes for Readmission After Total Hip and Total Knee Arthroplasty

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Introduction:

Readmission after Total Hip Arthroplasty (THA) or Total Knee Arthroplasty (TKA) places a great burden on the health care system. As hospitals and physicians are increasingly held accountable for perceived complications and post-operative readmissions, it is increasingly critical to understand the accuracy of coding for readmissions.

Methods:

We queried an electronic database for all patients who underwent THA or TKA at our institution from 2006 through 2010. We identified those who had been readmitted within 90 days of discharge from the initial admission. We then collected blinded clinical data and readmission diagnoses by ICD-9 code. Two senior-level orthopaedic residents performed a blinded analysis of the medical records of 87 random patients and assigned a diagnosis and ICD-9 code. These were analyzed for agreement using binomial proportion with 95% exact confidence limits.

Results:

Twenty-two of 87 patients were incorrectly coded for a rate of 25.3% (95% CI = 16.6%, 35.8%). Expecting at least 90% accuracy for coder-derived diagnoses, power analysis revealed 96% power in detecting the observed difference. The most common incorrect coding was related to post-operative stiffness and need for manipulation after TKA. There were several mis-categorizations regarding postoperative infection (cellulitis vs. wound dehiscence vs. deep infection).

Conclusions:

Readmission diagnoses are frequently coded incorrectly. The rate of mis-coding suggests the need for regular audits and highlights the need for clear documentation in the medical record. Use of readmission diagnoses without specific attempts to assure their accuracy may not be an appropriate quality measure given the frequency

with which errors occur.

Poster: 238
#865

Non-Invasive Measurement of Regional Intratendinous Strain Using Dynamic Ultrasound. an Ex-Vivo Validation Experiment.

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INTRODUCTION

Soft tissue balancing is a key aspect of total knee arthroplasty surgery and the successful restoration of the functionality of the knee joint. Improper balancing can lead to instability, post-operative recurrence of deformities and dislocation [1]. Proper understanding of those factors affecting soft-tissue balancing during surgery through real-time monitoring of in-vivo ligament strains pre-, intra- and post-operatively is of paramount importance.

Currently, intra-operative assessment of ligament balance is achieved with the use of spacer blocks, laminar spreaders and tensioning devices as well as by placement of trial components [1]. Unfortunately, this only allows for subjective and qualitative evaluation of ligament strains. Especially for pre- and post-operative monitoring, alternative non-invasive methods for measuring ligament strains are to the authors' knowledge not readily available.

The presented study evaluates the feasibility of automatic, intensity-based, spatio-temporal elastic registration for non-invasive local strain measurement by speckle tracking on dynamic ultrasound movies.

MATERIALS AND METHODS

Two phantom experiments, one with a simulated computer phantom and one with a physical model consisting of a gelatine-graphite mixture embedded in a custom build cyclic loading apparatus, were performed to demonstrate the method's performance in ideal settings. Furthermore, an isolated porcine patellar tendon (tendon length of 60 mm) with bone blocks at both ends was placed in a loading frame with an ultrasound transducer orientated along the long axis of the tendon (Figure 1). Ultrasound recordings were made while the tendon was cyclically loaded at two different velocities (1 mm/s and 2 mm/s) and three different maximal displacements (1.5 mm, 3 mm and 5 mm). Afterwards, a precalibrated strain-gauge extensometer was attached to the central 2.5 cm of the tendon and the same loading scheme was applied while recording ultrasound movies. The movies were processed, based on non-rigid elastic registration and speckle tracking, and these results were compared with the extensometer data.

RESULTS

Results on the computer and the physical phantom respectively show a maximal absolute RMS error of 0.05% and 0.2%. Ultrasound strain values were comparable to extensometer strain data in four measurements (A- velocity 1.0 mm/s, displacement 1.5 mm: 0.8% strain difference; B- velocity 1.0 mm/s, displacement 3.0 mm: 0.6% strain difference; C- velocity 1.0 mm/s displacement 5.0 mm: 0.7% strain difference; D- velocity 2.0 mm/s, displacement 1.5 mm: strain difference 0.1%) resulting in a mean strain difference of 0.55%. The measurements at velocity 2 mm/s for 3.00 and 5.00 mm displacement were omitted because of poor tracking in these recordings caused by additional motion which was not in line with the ultrasound probe's imaging plane.

CONCLUSIONS

The results of this study indicate that comparable strain values can be obtained between extensometer measurements and speckle tracking on non-invasive ultrasound recordings. Nevertheless, future research should focus on methods for taking into account out of plane movement, e.g. through the use of three-dimensional ultrasound.

REFERENCES

[1] W.M. Mihalko et al. Soft-tissue Balancing During Total Knee Arthroplasty in the Varus Knee. J Am Acad Orthop Surg, Vol 17, No 12, December 2009, 766-774.

Figures

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Figure 2

Poster: 239

#816

A Novel Method to Improve the Locking Screws Purchase in the Humeral Head

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INTRODUCTION

Various devices with favourable clinical and biomechanical results are available for implant fixation of proximal humeral fractures. [Sanders, B.S. et al., *J. Shoulder. Elbow. Surg* 2007] However, surgeons still report insufficient primary fracture stability when treating elderly patients. A possible reason for the persistent high percentage of fixation failure is that the implant design is not optimized for the bone characteristics of osteopaenic and osteoporotic patients. A novel method was developed to investigate bone properties of those regions engaged by locking implants [Schiuma D, et al., *Med Eng Phys*. 2011]. This method is based on a high resolution pQCT assessment of local bone mineral density (BMD) distribution and bone micro-architecture and it can also be used to drive the design of locking implants, by finding the optimal paths for the anchoring elements. The potential benefits on bone strain were investigated performing FE analysis on two models of fractured human humeri instrumented with a proximal humeral locking implant (Philos plate, Synthes GmbH).

METHODS

The Philos plates were mounted on twenty cadaveric humeri by inserting only the three most distal screws. The plates were removed and the bones were scanned at 82 μm resolution using HR-pQCT (SCANCO Medical). BMD was determined in the intact proximal epiphysis and in the exact locations where the six proximal screws would have been positioned after complete instrumentation. The two specimens with the largest BMD difference in the humeral head were selected. For each proximal screw, BMD was determined along the actual and four possible alternative screw paths (Fig.1). This procedure was aimed at identifying the directions with the best purchase in bone. The mechanical effect on the bone surrounding the screws was evaluated for the actual and optimized configurations using FE models developed with a standard procedure [Maldonado et al., *J Biomech.* 2003]. Plate and bones were meshed with tetrahedral linear elements. A specific Young's modulus was assigned to each bone element based on the measured local bone density. A two-parts fracture was modelled by decreasing the local Young's modulus to 5MPa (Fig.2). A 90° abduction load was applied and maximum principal strain evaluated. Univariate analysis of variance was used to compare the different positions with respect to BMD.

RESULTS

The results showed significant differences in BMD between screw positions. The BMD in position 1 was also significantly higher than in position 4 and 5 and that in position 3 significantly higher than in position 4 (Fig.3). Around the proximal screws of the optimized configurations, BMD increased by 28% and bone strain magnitude decreased by 43±1%.

CONCLUSION

The described HR-pQCT method allows the analysis of bone quality in custom-defined directions, avoiding metal artefacts, while taking into consideration the implant geometry and fixation technique. Different screw configurations were shown to affect bone strain distribution and magnitude during loading. The information on bone properties in specific areas engaged by the locking screws can be used as a tool to drive an implant optimization process.

Figures

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Figure 6

Poster: 240
#426

Periprosthetic Tibial Fractures Using the Minimal Invasive Medial Unicompartmental Knee Arthroplasty „Oxford Uni“

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Background:

Analysis of periprosthetic tibial fractures after performing unicompartmental knee arthroplasty (UKA) on fresh frozen tibia. Showing excellent clinical and functional results unicompartmental knee arthroplasties gain more and more importance in the supply of knee joints.

Periprosthetic tibial fractures are rare but serious complications. Usually they appear perioperatively and are caused by an error during implantation, especially by sawing defects. In a randomized study unicompartmental knee arthroplasty (UKA) was performed on 10 paired fresh frozen tibiae with and without placing sawing defects of 10° during tibial preparation. The specimens were fractured under controlled conditions with a standardized testing machine. Maximum fracture loads and load capacities were analysed subject to sawing defects.

Materials and Methods:

Twenty fresh frozen tibiae (10 corresponding pairs; donor data: f/m = 6/6, age = 75.7 years (47-92 years) and a weight of 65.7kg (32.7 – 136.1kg)) were analyzed with DEXA bone density measurement (BMD).

UKA was performed using a tibial sawing jig for standardized positioning of the sawing defect (10°). Customized tibial implants with sizes B to F were implanted.

The distal parts of the tibiae were cut off 20 cm distally of the tibial component. Specimens were fixed in a metal base fixture frame using polyurethane and maximum fracture loads of up to 10.000N were applied to the specimens using a standardized machine.

Group comparisons were done with the Wilcoxon-Test using SPSS for Windows 15.0 (SPSS Inc., Chicago, Illinois).

Results:

Maximum fracture loads in the group with 10° sawing defect were statistically significant lower than for the group without sawing defects. Mean fracture loads of 4,473N in comparison to 7,327N in the group without sawing defects could be seen.

Discussion:

Unexperienced surgeons seem to place vertical sawing defects while preparing the tibial plateau during UKA. These sawing defects most highly lead to periprosthetic tibial fractures.

Figures

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Figure 3

Poster: 241
#462

Clinical Results Associated With Changes of Posterior Tibial Slope in Cruciate-Retaining Total Knee Arthroplasty

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Purpose:

The purpose of this study is to investigate the effect of posterior tibial slope(PTS) change in total knee replacement arthroplasty on clinical results and patellofemoral joint.

Materials and Methods:

This study analyzed 801 cases of 768 persons who are operated on total knee replacement arthroplasty for osteoarthritis from July 2003 to July 2009. All cases were used cruciate retention type, mobile bearing. Mean age when they had been operated was 68 (61~87) years old and mean follow-up period was 51.3(12~72) months.

In this study, we measured PTS with simple X-ray film. And we divided patients into 5 groups according to the difference in PTS, which was measured by postoperative PTS minus preoperatives PTS. Group 1: more than +3 degree, Group 2: +3 to +1 degree, Group 3: +1 to -1 degree, Group 4: -1 to -3 degree, Group 5: less than -3. We analyzed the correlations between the change of PTS and the clinical results such as KS scores(Knee society knee score), Functional scores, Feller patella scores, Kujala scores, VAS score, ROM and complications. For statistical analysis, we used ANOVA test and the level of significance was below 0.05.

Results:

There were no statistical differences in each score for each group($P>0.05$), but Feller patella score and Kujala score that used to analyze to the effect on patellofemoral joint had significant difference in Group 2 and 3($P>0.05$). And there were no complications such as progressive loosening of implants, fractures of polyethylene inserts and wears.

Conclusion:

The perioperative change of PTS in total knee replacement arthroplasty using cruciate retention, mobile bearing type does not affect on functional scores and knee joint ROM except for Feller patellar and Kujala score. Therefore, we think that post-operative posterior tibial slope should be ranged from -3 degree to +1 compared to pre-operatively for enhancement of patellofemoral joint function. However more prospective and biomechanical study may be needed.

Keywords:

Knee, Patello-femoral joint, Posterior tibial slope, Total Knee Replacement Arthroplasty

Poster: 242
#463

Bony Landmark of Proximal Tibial Cutting Axis in Total Knee Arthroplasty

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Purpose:

To investigate new useful bony landmark of the anterior and posterior tibial axis in total knee replacement arthroplasty.

Materials and Methods:

From October 2006 to July 2008, we took computed tomography of 132 people who have a no deformity of a hip and ankle joints, then computerized them. We defined medial-lateral axis by femoral transepicondylar axis and transferred to tibial plateau surface. From that line, the line runs through posterior notch defined as anterior-posterior axis. We measured α(the angle between AP axis and tibial tuberosity medial one-third space), β(the angle between tibial anterior border at the tibial mid-shaft area) γ(the angle between anterior tibial border at the superior surface of ankle joint) as degree of curl.

Results:

Included angle between the line passes through posterior notch 1/3 point of tibial tuberosity and the anterior and posterior tibial axis (α°) checked 19.1±4.4°(8.3~28.7°) on average and rotation degree was 25° on average in 110 people(83.3%) in computerized tomography. The angle between the line runs from posterior notch to tibial axis in the middle part of tibial shaft and the front and rear tibial axis (β°) was measured 9.5±3.4°(1.6~18.5°). It appeared a significant difference in Wilcoxon signed rank test. ($p<0.001$), It showed no statistical meaning that the inluded angle, between the line runs from the posterior notch to the anterior border of tibia and the anterior and posterior tibial axis which measured from the superial part of ankle joint (γ°) was measured 2.5±6.9°(-5.8~14.3°).

Conclusion:

In case of TKRA, the middle point of anterior border of tibial axis is a useful indicater compared to the medial one-third of tibial tuberosity. This will be a good indicator because it's easy and simple to measure.

Keywords:

Total knee replacement of arthroplasty, anterior and posterior tibial axis, bony land mark, anterior border of tibia

Poster: 243
#972

Trivector Arthrotomy for TKR - a Gateway for All Knees

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Introduction:

During TKR it is mandatory to achieve perfect soft tissue balance and component alignment. It is necessary to access all tight structures for proper releases. As knee is covered in front by quadriceps mechanism, there is some manipulation of this structure while approaching knee for an arthroplasty. This alteration in Quadriceps mechanism can affect outcome of the surgery.

Aim:

To analyze the results of Trivector arthrotomy for TKR surgery.

Methods:

It is a retrospective study of 338 cases operated during 2008-2010. All the cases were performed by the author.

Inclusion criteria: Primary TKR with any degree of deformity.

Exclusion criteria: Revision TKR

Very fragile and thin patients.

Surgical Technique – Approach includes dividing distal 30% of vastus medialis along with medial retinaculum 1cm. medial to patella and patellar tendon distally up to Tibial tuberosity. This is raised as a single flap with knee in flexion. Patella is everted with knee in extension. Knee flexed to expose the knee articulation and rest of the

arthroplasty carried out. The watertight closure of the arthrotomy is by 1no. vicryl interrupted stitches. (video clipping)

Results:

None of the cases were lost to FU. 203 cases Varus + FFD, 108 Varus alone, 15 Valgus, 9 hyperextension deformity, 3 neutral alignment cases were included. Results showed 87% pt.s at 1st postop day and 96% by 4th day regained ability to perform unassisted SLR. 4% had 5to 10 degree quadriceps lag at discharge which recovered to neutral by 4 wks. The surgical field was adequate in all cases and did not have to be extended the arthrotomy incision. KSS score improved from av. Pre op of 56 (38-71) to an average post op of 92 (84-96). All patients by 7 to 10 days were walking unaided or with a single cane in case of Bilateral TKRs.

Discussion:

Medial parapatellar arthrotomy divides the quadriceps tendon. The alteration in various vector limbs of Quadriceps can change the balance and laterally maltrack the patella. Incidence of Lateral release is higher in Medial parapatellar arthrotomy cases.

Mid and subvastus approaches are non extensile and hence poor visibility during surgery. Incidence of malalignment is higher when the visibility is poor.

Trivector arthrotomy approach is extensile and retains 70% strength of vastus medialis. At the closure the quads mechanism is perfectly aligned and hence the incidence of lateral maltracking and lateral release minimized. It is easily reproducible and can be used in stiff knees, severe varus, valgus, obese and post HTO TKRs with consistent results.

The 4% cases who had quadriceps lag were probably transient neuropraxia to the muscular branch of the medial superior genicular nerve. They all recovered at 4 wks. Follow up.

Conclusion:

The extensile nature of the approach and minimal disruption of the quadriceps mechanism encourages us to use this approach for all our cases. It is a true “Gateway” for all knees for TKRs.

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The trivector Knee arthrotomy approach: Kenneth Bramlett

Poster: 244
#812

Analysis of Non Linear Tka Contact Mechanics Using Spring Networks

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INTRODUCTION

Finite elements analysis (FEA) has become the golden standard for the analysis of contact mechanics in total knee arthroplasty (TKA). However, computational speeds, especially when conducting a non-linear FEA analysis, is a major limiting factor for performing design sensitivity and optimization studies of TKA. Alternatively, the use elastic foundation models (EFM), in which the deformable polyethylene insert is modeled as a series of discrete and independent springs has been promising. However, in EFM, since deformation of one spring does not influence deformation in others, predictions can differ considerably from FEA. In this research, we explore the effectiveness of modeling the deformable polyethylene insert as a spring network model (SNM).

METHODS

First different SNM analogues of hexahedral elements were tested. Deformation and contact pressure distribution,

under mesh refinement, of SNM connections using nearest neighbor (NN), next to nearest neighbor (NNN) and next to next to nearest neighbor (NNNN) assemblies (Figure 1) were compared with a matched node FEA simulation of non-elliptic flat on flat contact under an axial load. The best SNM network was applied to simulate elliptic contact in a fixed bearing PCR TKA. Computational performance for a sufficiently refined SNM mesh was compared to FEA analyses in ABAQUS. The Ramberg-Osgood material model was used to represent polyethylene.

RESULTS

In the non elliptic flat on flat contact tests, the maximum contact deformation (top nodes) in FEA was independent of the mesh size. However, the performance of the SNM structures were found to be size dependant with finer meshes having lesser differences when compared to FEA (Figure 2). The fastest convergence was observed using the NNNN SNM architecture. This architecture is a combination of body centered cubic (BCC) and face centered cubic (FCC) lattice model where each interior node is connected to 26 surrounding nodes (8 BCC and 18 FCC). For grid sizes less than 1mm differences in the maximum deformation between this SNM structure and FEA were less than 2%.

In the elliptic contact tests involving the TKA implants, the prediction of the SNM model and FEA for an average grid size of 1.0 mm were almost identical (differences less than 1%) in terms of maximum deformation, contact area and magnitudes and distribution of contact pressures (Figure 3). Computationally, the SNM models were significantly faster than the FEA models. On a 1.8 GHz core-2-duo processor with 2GB of RAM, the solution time for the SNM models varied between 17 sec to 2.3 minutes while for FEA using ABAQUS, the solution times varied from 16 minutes to 47 minutes.

DISCUSSION

The global stiffness matrix in SNM is more banded and can be assembled algebraically. This reduces computational time over FEA during a non-linear analysis when the global stiffness matrix and its inverse are constantly updated for a solution. However, SNM architectures are highly size dependant and can behave stiffer for coarser mesh sizes. For finer meshes, the difference decreases and under infinite degrees of freedom FEA and SNM are essentially equivalent.

Figures

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Figure 6

Poster: 245
#630

The Validation of a Predictive Physiological Model of the Knee

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Orthopaedic companies have recently used predictive, or “forward solution”, models of the knee during the design phase of new total knee arthroplasty (TKA) designs. These models typically simulate cadaveric simulators and are validated by comparing the model results to the results from the cadaveric rig experiments. Typically only the kinematics are validated and rarely are kinetic results, namely the tibiofemoral (TF) contact forces described. This current study validates the kinematic and kinetic results from a physiological predictive model of the knee with in vivo data.

Computed tomography (CT) scans were performed on five subjects who also performed activities under fluoroscopic surveillance. Models built from the CT scans were used to obtain the three dimensional (3D) joint kinematics using fluoroscopic analysis. A 3D forward solution rigid body model was developed of the two activities analyzed, namely non-weight bearing extension and weight bearing deep knee bend (DKB). Parameters

such as ligament and muscle origin and insertion, inertial parameters and articulating geometry were obtained from the models of one of these subjects (Subject 3). The anterior/posterior (AP) TF contact kinematic results from the simulation were compared to the in vivo kinematics from all of the subjects for both activities. The geometry from a fixed bearing TKA instrumented with strain gauges was also "virtually implanted" into the DKB model. The TF contact kinematics and contact force results were compared to in vivo data previously collected from a subject implanted with the same implant.

The simulated AP TF contact position patterns matched the in vivo data trends for all simulations described in this study. The simulated normal extension kinematics were close to the in vivo results from Subject 3 on both the medial and lateral sides, with the greatest deviations being 6.9 mm and 3.2 mm, respectively. For the normal DKB simulation the medial contact position remained more anterior than what was seen in vivo, however the lateral AP contact position matched the in vivo results from Subject 3 with the greatest deviation being 2.1 mm. In vivo, the medial and lateral TF contact positions of the subject implanted with the instrumented TKA had very similar kinematic patterns. The simulation behaved the same although the contact position was slightly more posterior on the order of millimeters from 10 to 80 degrees knee flexion. The total TF axial force of the implanted simulation also matched the trend of the in vivo TF forces. The maximum simulated TF force was within 3.1% of the maximum in vivo force. The initial validation of this model is one of the first to use both in vivo kinematics and kinetics to validate a physiological predictive model of the normal and implanted knee. This is the first stage of developing a tool which orthopaedic companies can use in their design process to improve efficiency and also improve the ultimate device.

Figures

Poster: 246
#523

Pedobarographic Changes After Navigated Total Knee Arthroplasty

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Accurate restoration of limb mechanical axis aims to equalise weight distribution across the knee joint after total knee arthroplasty (TKA) which has a bearing on wear and longevity of the implant. Limb mechanical axis is an indirect measure of weight distribution along the lower limb which does not take into consideration the foot. Assessment of foot pressure is a direct method to assess the distribution of the weight across the lower limb which has seldom been evaluated in patients who have undergone TKA. This study aimed to assess the pattern of foot pressure distribution in patients with deformed arthritic knees and how it changes after accurate restoration of limb mechanical axis with TKA.

We prospectively evaluated the preoperative and 3-month postoperative foot pressure distribution on single-leg stance using pedobarography in 65 limbs which underwent navigated TKA. The mean preoperative knee deformity of 171.3°±9.7° (range, 150° -195°) improved to a mean 179°±7.6° (range, 175°-184°) after TKA. Postoperatively, there was significant increase (p=0.001) in mean pressure in the hindfoot region than in the forefoot or midfoot areas when compared to preoperative values. In the hindfoot area, the medial hindfoot showed significant increase (p=0.0001) in mean pressure than the lateral hindfoot after TKA. Similarly, the medio-lateral (MLR) and the hindfoot-forefoot (HFR) pressure ratios increased significantly after TKA.

Despite accurate restoration of limb alignment after navigated TKA, there is a tendency for body weight pressure to shift significantly from the forefoot to the hindfoot and from the lateral aspect of the hindfoot to the medial aspect. Implications of these pressure changes on implant survival needs to be further evaluated.

Poster: 247
#557

How Accurate Are Orthopaedic Surgeons in Visually Estimating Lower Limb Alignment?

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Intraoperative assesment of limb alignment in the coronal and sagittal plane is an important part of many surgical procedures in orthopaedic surgery such as corrective osteotomies, high tibial osteotomy and total knee arthroplasty. This is usually performed intraoperatively either visually or with a goniometer. However, there are no studies in the literature which have assessed the accuracy of the orthopaedic surgeon in visually estimating limb alignment.

This study aimed to determine accuracy and reliability of visual estimation of limb alignment and knee flexion by orthopaedic surgeons when compared to recordings done by computer navigation. Orthopaedic surgeons attending a national conference were asked to place a lower limb synthetic bone model in 6 positions of the knee in the coronal and sagittal planes. These were simultaneously quantified and recorded by a computer navigation system.

In the sagittal plane, 44% , 54% and 60% of the surgeons deviated by more than 5° when positioning the knee in 0° flexion, 10° flexion and 90° flexion respectively. In the coronal plane, 15%, 12% and 8% of the surgeons deviated by more than 5° when positioning the knee in 0° varus/valgus, 5° varus and 5° valgus respectively. Only 25% of the surgeons could position the knee both within 3° of neutral varus/valgus and within 5° of neutral flexion. Intra and interobserver correlation coefficient (ICC) showed poor intra and interobserver agreement for 5° valgus and all 3 sagittal positions of the knee and accuracy of visual estimation was not different when surgeons were compared based on time since residency, experience with TKA and experience with computer-assisted TKAs.

Visual estimation of knee alignment in both the sagittal and coronal plane is prone to error and may lead to inaccurate limb alignment during procedures such as TKA.

Poster: 248
#606

Reproducibility of Femoral Stem Anteversion in Total Hip Arthroplasty (THA)

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[introduction]

In this study, the total hip arthroplasty (THA) was operated for the patients who have one side of osteoarthritis and the other side is normal hip joint. We defined the anatomical femoral anteversion of the normal side at each patient and operated to reproduce the femoral anteversion angle of the normal side. The pre-operative femoral anteversion and post-operative anteversion of femoral stem were measured compared with the normal side and evaluated the accuracy of the stem anteversion.

[methods]

100 THAs were undergone at an institution during four-year period beginning in 2007. All patients were caused by osteoarthritis after developmental dysplasia , and the other side of hip joint was normal.There were 24 male and 76 female patients. Average age at operation was 64 years old. According to the Crowe classification, 88 patients were classified as Group I, 10 patients were classified as Group II and two patients was classified as Group III. The operations were performed by mini incision approach, inter muscular anterolateral (IMAL) approach was undergone in 88 THAs and posterolateral (PL) approach in 12 THAs. We measured the pre-operative femoral anteversion and post-operative stem anteversion by computed tomography and evaluated the accuracy of the stem anteversion to consider the anatomical anteversion.

[Result]

The normal femoral anteversion was 18.3 ± 10.0°(range,0.3 - 43.2°). Pre-operative femoral anteversion of osteoarthritis side was 19.6 ± 9.4°(range,1.6 - 37.5°). Post-operative femoral stem anteversion was 17.5 ± 8.7° (range,1.0 - 33.9°). The absolute error between normal femoral anteversion and post-operative stem anteversion at each patients was 7.8 ± 6.6°(range,0.6 - 25.3°) , the error between pre-operative femoral anteversion of operative side and post-operative stem anteversion was 6.7 ± 4.7°(range, 0 - 20.1°). The stem anteversion of IMAL approach was 17.1 ± 8.4° and that of PL approach was 21.4 ± 8.8°.

[Discussion]

In this study, pre-operative femoral anteversion of the osteoarthritis side was bigger compared with the normal side, but there was no significant difference.The rotation moment of lower extremity was provided by the femoral anteversion. Therefore, a right and left femoral anteversion of each patients is hoped symmetrical.We performed the THA about stem anteversion at the operative side to recreat the femoral anteversion of the normal side. And thus the absolute error of accuracy was about 8 degrees, it was considered that we could almost recreate the anatomical femoral anteversion. There was the tendency that the stem anteversion operated by IMAL approach was smaller than by PL approach. It was thought to cause that we choose PL approach for the severe deformity cases.For the improvement of the accuracy of the stem anteversion, we have been considering the THA with navigation system and the development of rapid prototyping bone model.

Poster: 249
#809

High Wear Rate Using Conventional UHMWPE. a Long Term Clinical Follow Up Study

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INTRODUCTION

Cementless Total Hip Replacement surgery is a well established procedure for relative young patients with severe hip disease. Excellent long term clinical results have been published on the performance of the femoral component. With growing clinical experience, our concern focused on excessive wear of the Ultra High Molecular Weight Polyethylene (UHMWPE) ringloc liner of the Mallory Head cementless Total Hip Prosthesis. After its introduction in our clinic in 1997, this implant is still in use without any modification. We were concerned that due to premature liner wear, the performance of this implant would not be compliant with the international guideline on implant survival (NICE guidelines: at 10 year follow up, ≥ 90% of all implants should still be in situ). Our objective was to establish the amount of liner wear in our first 200 MH implants.

METHODS

Our first 200 patients consecutively treated with Mallory Head prostheses were followed up to obtain a recent digital image. Follow up was complete for 181 (90.5%) of our 200 patients. Ten had died and nine were not able or willing to come for follow up. The mean duration of follow up was 8.3 years (range: 8 – 13). The 181 recent digital images were classified as either excessive wear or no excessive wear by two independent orthopedic surgeons. Next, liner wear was measured in the 2D frontal plane using PolyWare Pro/3D Digital Version Rev 5.1 software (Draftware Developers, Conway, USA). A threshold for excessive liner wear was set at 0.2mm/year, according to literature.

RESULTS

Using software for measuring PE wear, 46.7% of all patients had excessive UHMWPE wear (> 0.2mm/yr). There was no relation between the amount of wear and BMI, gender, component size or the acetabular inclination angle. Thirteen patients (6.5%) were revised. Nine of these revisions were for excessive liner wear or aseptic loosening (4.5%). For now, our series of cementless Mallory Head prostheses is compliant with the NICE guideline on implant survival. However, with the measured amount of wear we expect to see a significant increase in the number of revisions for liner wear in the near future.

DISCUSSION

Our clinical observation of premature UHMWPE wear proved correct. The measured amount of UHMWPE wear is consistent with the few other studies published on this subject. Although we present a retrospective study, limiting the strength of our results, we have included a large group of patients with acceptable loss to follow up. It is unclear if the observed wear will lead to a sharp increase in the number of revisions within the next few years. Possibly, future revisions will be complicated by loss of acetabular bone stock following the pathofysiological

reaction to wear particles. Our results can probably be generalised for any district hospital.

Poster: 250
#927

Short Stem Minihip vs Long Stem Metafix; Hip Mechanics Following THR.

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Introduction

More conservative, short stems have been recently introduced to attempt to better replicate the physiological load distribution in the femur, to minimise bone loss and improve the long term survival of the implant. In addition, the conservation of bone stock is important when considering revision surgery because a lack of viable bone stock may compromise the longevity of the revision prosthesis. The aim of this study was to evaluate the performance of two cementless hip replacement designs; a long and a short stem THR. The effect that oversizing the short stem had on the mechanical environment was also investigated.

Methods

Two physiological load cases (gait and stair climbing) were simulated in finite element models of a short and long hip stem, implanted into a cadaveric femur. The three dimensional geometry of the femur was constructed from computed tomography data of the donor (female, 44 years old, right side). Elemental bone properties were assigned from the Hounsfield Unit values of the CT scans. Four sizes of the short stem device were modelled. Of the short stems, the size 2 was the correctly sized implant for the femur. Strains along the medial and lateral aspect of the femur were analysed for each stem and were compared to the unimplanted femur. Strain energy density was compared in established Gruen zones.

Results

The average compressive strain along the medial cortex for the unimplanted femur for stair climbing and gait was 297microstrain and 248microstrain respectively. The corresponding strain for the long stem and frictional contact was 25% and 32% lower respectively. The corresponding strain for the size 5 short stem was 16% and 26% lower respectively. The corresponding strain for the size 2 short stem was 3% and 12% lower respectively.

For the long stem implanted femur, the respective SED in Gruen zones 6 and 7 was 42% and 43% higher compared to the unimplanted femur. For the size 2 short stem, the corresponding SED was 40% and 12% higher, compared to the unimplanted femur. For the short stem the SED in Gruen zone 3 was 1% higher than that for the unimplanted femur.

Discussion

The correctly sized short stem (size 2 Minihip) transferred considerably more load into the proximal femur compared to the long stem. In addition, there was 20% less bone resected for the size 2 short stem. Should the short stem be incorrectly oversized (via a lower neck resection) the resulting proximal strains were similar to those observed with the long stem.

The short stem implant offers less mechanical disturbance on the femur, causing less bone loss in most zones and even inducing bone ingrowth in the lateral /distal region. Short stem implants have the potential to be more bone conserving compared to conventional stems, and to minimise periprosthetic bone loss when correctly sized and implanted.

Poster: 251
#680

Effect of Tibial Component Design Upon Final Position During Robotic-Arm Assisted Unicompartmental Arthroplasty (UKA)

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INTRODUCTION:

We have previously reported that bone preparation is quite precise and accurate relative to a preoperative plan when using a robotic arm assisted technique for UKA. However,, when using an all polyethylene inlay tibial component, we found a large variation between intended and final implant position after cement curing, despite real time tracking of the implant. In a separate study, we reported that independent cementing of the femoral and tibial components decreased but did not eliminate this variation when using the same implant. In this study, we reviewed a third cohort of patients in which the tibial and femoral components were cemented simultaneously, but an onlay tibial component with a keel and peg was utilized. Final component position relative to bone preparation psition was evaluated.

METHODS AND MATERIALS:

Group 1 comprised the cohort of patients in whom inlay tibial components were simultaneously cemented with the femoral component. Group 2 , the study group, consisted of a cohort with a modular metal onlay keeled component simultaneously cemented with the femoral component. Postoperative x-rays from each cohort of patients were evaluated using image analysis software. Statistical evaluation was performed.

RESULTS:

In Group 1, average bone preparation was 5.13 + 2.70 degrees of varus and 7.40 + 2.59 degrees of posterior slope. Final implant position was 3.56 + 1.93 degrees of varus and 5.19 + 3.37 degrees of slope. The variance from intended position was 2.31 + 1.74 degrees of varus and 3.80 + 2.90 degrees of slope. For Group 2, average bone preparation was 4.14 + 1.92 degrees of varus and 6.62 + 2.86 degrees of posterior slope. Final implant position was 4.54 + 2.47 degrees of varus and 6.68 + 2.69 degrees of slope. The variance from intended position was 0.59 + 0.61 degrees of varus and 0.46 + 0.30 degrees of slope. One way ANOVA revealed no differences between groups regarding bone prep in the coronal and sagittal planes, or final component position in the coronal or sagittal planes. Variance from intended position was significantly smaller in the coronal ($p<0.0001$) and sagittal ($p<0.0001$) planes.

CONCLUSIONS:

The use of a robotic arm has been shown to be extremely accurate for bone preparation relative to a preoperative plan. However, implant design and associated cementing technique can influence final component position and undermine the accuracy of the robotic arm. In this study, the use of a keeled and pegged tibial component significantly reduced variation from intended position. Therefore, in order to achieve the goal of accuracy and precision when performing robotic arm assisted UKA, we recommend use of such a style of tibial component.

Poster: 252
#598

Increase in Fatigue Strength by Mechanical Surface Treatments of a Ti-6-4 Alloy for Cementless THA

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Background

Ti-6-4 alloys are mainly used for cementless total hip arthroplasty (THA). In order to fulfil today's trends to minimal invasive and bone preserving approaches, critical components (e.g. modular necks) have a sophisticate design. Although implant fracture is a rare complication it is a serious event that is often related to a specific implant design.

Today, surface treatments that induce superficial residual stresses, e.g. shot peening, are widely applied in mechanical engineering and aerospace. In particular cases, critical implant regions, e.g. taper surfaces of revision

implants, are subjected to a terminal shot peening treatment, too. The present study aims to compare different surface treatments - shot peening (SP), ultrasonic shot peening (U-SP) and roller burnishing (RB) - according to their potential to increase the fatigue strength of an established Ti-6-4 alloy.

Materials and Methods

Hour-glass shaped specimens [Fig. 1] made of a Ti-6-4 alloy have been subjected to an annealing treatment at 620°C for 10h to remove initial residual stresses introduced during manufacturing. 6 specimens in each case have been subjected to an additional surface treatment: A.) SP with cut wire and a subsequent cleaning process with glass beads, B.) RB at 300bar with a 6mm hard ball and C.) U-SP with ceramic beads (0,5<d<5mm). Roughness measurements have been performed on the treated surfaces. Subsequently, residual stress measurements on all three cases were conducted using Fe-filtered Co-Ka-radiation, calculated by the $\sin^2\psi$-method and compared to an annealed specimen. Depth profiles were taken using subsequent electrochemical polishing. Fatigue strength was determined using servo-hydraulic hydropulsers at 10Hz and a load ratio of R=0.1 for a maximum of 10^7 cycles. The specimens have been loaded until fracture occurred or the total number of cycles has been reached. The fracture surfaces have subsequently been investigated for failure analysis.

Results

The surface roughness of the specimens differed significantly after treatment ($p<0,01$) with the smoothest surface for RB (Ra=0.87μm). On the other hand, surface roughness for SP and U-SP increased to 2.02μm and 0.88μm, respectively, compared to 0.24μm for the annealed specimens. Surface treated Ti-6-4 showed considerable influence on the fatigue strength [Fig.2]. Compared to the annealed specimens U-SP, SP and RB increased the fatigue strength after 10^7 cycles by 10.1%, 12.3% and 13.3%, respectively, which can also be seen in the residual stress depth profiles. In all cases, the fracture surfaces showed a typical fatigue failure pattern.

Discussion

Fatigue testing of surface treated Ti-6-4 specimens has shown that the fatigue strength can be considerably increased even after a long term testing period of 10^7 cycles. Therefore, additional surface treatments should be considered as appropriate tool to strengthen critical implant components that are subjected to high stresses, e.g. the neck or stemmed region of a THA implant. Future research will be done to consider further surface treatments, e.g. laser shock peening.

Figures

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Figure 2

Poster: 253
#881

Comparison of Four Different Metal Implant Screws for Their Osseointegrative Properties: A Biomechanical and Histological Study in Sheep

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Objectives:

Fast and stable bone formation around a metal implant screws is important for the overall outcome and survival rate of the rehabilitation. Long-term success of endosseous implants has continually improved over the last decades, such that osseointegration into cortical and cancellous bone has been considerably refined by appropriate implant designs as well as better choices of implant materials. In the present study four different metals and metal-alloys (coated or polished) were tested for their osseointegration, removability and biocompatibility on the basis of a pelvic model in sheep.

Materials and Methods:

Seven female swiss white alpine sheep between 2 and 4 years of age (average 3.3), with an average body weight of 76.9 kg (range 51–98 kg), served as experimental animals and were randomly allocated to three groups with each 2 animals. One sheep served as an own group. Nine implants were placed in each side of the pelvis (n=18 per sheep). All implant screws (total n=126) had a length of 14mm and diameter of 3.5 mm and were randomized over the implanation sites. Implant screws to be evaluated were: Cobalt-Chrome (CC), Cobalt-Chrome/ Titanium coating (CCTC), Cobalt-Chrome/ Zirconium/ Titanium coating (CCZTC), Pure Titanium Standard (PTST), Steel, Titan-Aluminium-Niobium Standard (TANST) and Titan-Aluminium-Niobium polished (TANSTP). After 8 weeks the specimens were removed and evaluated macroscopically, radiologically, biomechanically, histomorphometrically as well as histologically.

Results:

Cobalt-Chrome screws showed significantly (p=0.031) lower torque removal values than pure titanium screws and also a tendency towards lower values compared to the other materials, except for steel. Steel screws had no significant differences in comparison to cobalt-chrome and TANST screws, however also a trend towards lower values than the remaining materials. The results of the fluorescence sections overlapped with those of the removal-torque-test. Histomorphometrically there were no significant differences between the groups. The BIC (Bone-to-implant-contact), used for the assessment of the osseointegration exposed a significantly lower contactline of cobalt-chrome compared to steel with a significance of 0.001. Steel again, showed a lower ratio (p=0.0001) compared to the other materials.

Conclusions:

This study was able to prove, that cobalt-chrome and steel show lower osseointegration than the other metals and metal-alloys and thus are much easier to remove. Yet ossseointegration can be increased by coating cobalt-chrome with zirconium and/or titanium. Titanium-alloys (TANST, TANSTP) do not vary from pure titanium in their osseointegrative behaviour.

Poster: 254
#843

Mobile Compression Devices With Aspirin Following Total Knee Arthroplasty: An Effective Alternative to DVT Chemoprophylaxis

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Introduction:

Venous thromboembolic disease remains a major source of morbidity following total joint arthroplasty. Several forms of thromboprophylaxis have been recommended including antiplatelet drugs, intermittent pneumatic compression of the leg, standard or adjusted low-dose heparin, oral anticoagulants, and more recently, low-molecular-weight heparin (LMWH). There is still no consensus as to what constitutes the most appropriate strategy for prevention of this complication. Several investigators have compared the continuous enhanced circulation therapy (CECT) system combined with low dose aspirin to enoxaparin (Lovenox) in total hip arthroplasty and found that the CECT cohort had no statistical difference in overall rate of DVT and proximal DVT. Our study objective was to carry out a randomized, prospective study comparing the CECT system with our

institution's standard chemoprophylaxis protocol in patients undergoing total knee arthroplasty.

Materials and Methods:

Patients undergoing total knee arthroplasty with no history of clotting disorders were randomly assigned to continuous enhanced circulation therapy (CECT) with aspirin for 2wks or Coumadin for 2wks with a LMWH bridge. All patients in the study underwent lower extremity duplex prior to discharge on day 3. Primary end points include DVT and PE.

Results:

Of the 50 patients enrolled, 19 were male and 31 were female. There are 25 patients in the control group and 25 patients in the CECT experimental group. The rate of DVT in the control group was 8% and the rate in the experimental group was 12%, which is not statistically significant (p-value 0.64). There were no PE's in either group. Compliance in both groups was equivalent.

Conclusion:

There was no statistical difference between the CECT group and the Coumadin/LMWH group with regard to DVT and PEs in patients undergoing total knee arthroplasty. The CECT offers a safe and effective method of DVT/PE prophylaxis and minimizes bleeding complications in addition to minimizing costs related to medications and dosing services.

Poster: 255
#683

A Single US Surgeon Experience With the Adoption of Hip Resurfacing Using 3 Different Implants

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Hip resurfacing has grown rapidly since its introduction in the United States, as an alternative to total hip replacement in the younger, active patient. Some studies have suggested a steep learning curve and a higher complication rate when compared to THR. Existing studies have originated from the pioneering surgeons, using a specific type of resurfacing implant. The purpose of this study was to look at the experience of a single, non-inventor surgeon with the adoption of hip resurfacing, using 3 different implants.

M&M
All consecutive hip resurfacings performed by the senior surgeon between 2004 and 2009 were included, providing a minimum 2 year followup period. 3 different implant types were used; 2 of these were used as part of the clinical trials, and 1 was used after US FDA approval. A total of 925 hip resurfacings were eligible for the study based upon a minimum of 2 year followup.
Clinical scores and radiographs were collected. Serum cobalt and chromium levels were performed on a subset of the cohort, using HR-ICP mass spectrometry.

Results
Twelve revisions were performed in this cohort (1.3%). 2 were femoral conversions to endoprostheses for femoral neck fracture; 5 additional femoral conversions were done for osteonecrosis of the femoral head. 1 acetabular revision only was performed for malposition. 3 revisions to THR of both the acetabular and femoral components were done for acetabular loosening (n=2) and excessive metal production (edge loading). There was 1 revision for metal hypersensitivity. Overall, the K-M survival curve is 98.1% at 6 years. There was an increased incidence of revision in the Conserve Plus cohort (3.8%) vs the other groups; BHR (0.8%), and Biomet (0%).
Serum metal levels were performed on a subset of patients. There was a significantly lower level of cobalt and chromium levels with the Biomet Recap implant, as compared to both the Conserve Plus and BHR implants.

Discussion
Hip resurfacing can be adopted successfully with a low rate of reoperation, by the use of careful patient selection. A single surgeon's experience with 3 different types of implants demonstrated a possible difference in short- to mid-term survival, with lower metal levels with the Biomet Recap implant. Longer term followup is necessary to ascertain whether or not these findings will be maintained.

Poster: 256
#690

Treatment for Fractures of the Elbow Region in Elderly Patients Open Reduction and Internal Fixation vs Total Elbow Arthroplasty

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[Purpose]

The purpose of the present study was to compare open reduction and internal fixation (ORIF) with total elbow arthroplasty (TEA) for fractures of the elbow region in elderly patients.

[Patients]

Between 2003 and 2010, 16 patients over 65 years old with a fracture in the elbow region were treated with ORIF or semiconstrained TEA. There was a male and eight female with a mean age of 79.5 years in the ORIF group and a male and six female with a mean age of 76.3 years in the TEA group. There were two patients with a nonunion of the distal humerus and two patients who had a fresh fracture with a nonunion of a part of distal humerus in the TEA group. The mean follow-up period was 21.1 months in the ORIF group and 17.4 months in the TEA group.

[Results]

In the ORIF group, one patient required a hardware removal due to an infection. Her elbow healed after the additional surgery with an external fixation. In the ORIF group, one patient had slight pain and four patients had moderate pain. In the TEA group, two patients had slight motion pain and no patients had moderate pain. The average extension was -28.8 degrees in the ORIF group and -11.4 degrees in the TEA group. The average flexion was 116.3 degrees in the ORIF group and 132.9 degrees in the TEA group. The flexion angle was significantly different between the ORIF group and the TEA group ($P<0.05$). Mayo elbow performance scores were 77.8 in the ORIF group and 95 in the TEA group.

[Conclusion]

TEA is considered to be a more useful treatment to acquire pain relief and improve elbow function in elderly patients with fractures of the elbow region compared to ORIF.

Poster: 257
#695

Development of a Navigation System in Total Elbow Arthroplasty

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Purpose

It is often difficult to determine proper rotational position of the implant when performing total elbow arthroplasty (TEA) in rheumatoid arthritis (RA) elbow with a large bone defect. To develop a navigation system for TEA, selecting bony landmarks that can be identified intraoperatively is important. The purposes of this study are to extract bony landmarks that are useful in determining rotational position of implants, to investigate variation of the bony landmarks in normal elbows, and to clarify if the bony landmarks are usable in RA elbows.

Materials & Methods

Three-dimensional CT data of the elbow of 11 normal volunteers (8 men and 3 women, average age; 33.0 years) were obtained and the following bony landmarks were extracted: 1) posterior aspect of humerus, 2) line connecting lateral and medial epicondyle, 3) horizontal axis of trocholea, 4) sagittal axis of trocholea, 5) joint surface of ulna, 6) ulnar aspect of proximal part of ulna. And the angles between those landmarks were measured as follows: angle A; 1)-2), B; 1)-3), C; 2)-3), D; 4)-5), E; 4)-6), F; 5)-6). It was investigated if those landmarks were usable in 12 RA elbows (all women, average age; 52.3 years).

Results

In normal elbows, the measured angles were A; 11.5 ± 4.3 (deg.), B; 9.5 ± 6.4, C; 6.0 ± 2.8, D; 80.0 ± 14.0, E; 7.0 ± 12.1, F; 91.5 ± 3.5. In RA elbows, posterior aspect of humerus, line connecting lateral and medial epicondyle, and ulnar aspect of ulna were able to be identified in all cases; whereas horizontal and sagittal axis of trocholea, and joint surface of ulna were unable to be identified because of the erosion of the bone in 5, 7, and 7 cases, respectively.

Discussion

The 6 bony landmarks showed small variability in normal elbows and were considered to be usable as intraoperative landmarks for determining rotational position of implants. In RA elbow, posterior aspect of humerus and ulnar aspect of proximal part of ulna were able to be identified even if there is a large bone defect that extends to the lateral or/and medial epicondyle The results of this study provided useful data for developing new navigation system of TEA.

Poster: 258
#696

Short-Term Results of MIS-TEA for Rheumatoid Arthritis

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Purpose:

Though the clinical outcome of TEA for RA elbow is mostly satisfactory, complications of skin problem or disturbance of the triceps due to the traditional posterior approach have been reported. We have performed MIS-TEA using a new approach without excision or detachment of the triceps tendon and subcutaneous release since 2008. The purpose of the current study is to evaluate the short-term results of MIS-TEA for RA.

M&M:

Twelve elbows of 10 patients that overwent MIS-TEA using Solar Elbow (Stryker) were included in this study. There were 3 men and 5 women, and the average age at the operation was 67.8 years old (range: 54-78). Larsen grade was Grade 3; 3 elbows, Grade 4; 4 elbows, and Grade 5; 7 elbows. From medial approach, joint was exposed along the incision of the medial border of the triceps. No subcutaneous release on the olecranon was performed and the triceps tendon was preserved. An original alignment guide was used for appropriate placement of the implant. After 2 weeks, muscle and ROM exercise of the elbow was started. The Japan Orthopaedic Association elbow score (JOA score; consisting of pain (30 points), ADL (12 points), muscle strength (8 points), ROM (30 points), instability (10 points), and deformity (10 points)), Mayo Elbow Performance score (MEPS), ROM, and complication were evaluated preoperatively and at the final follow-up. The average follow-up period was 20.1 months (range: 12-30). Statistical evaluation was performed using the Wilcoxon signed-rank sum test ($p<0.05$; significant).

Results:

JOA score and pain score significantly improved postoperatively, from 52.8 points (36-68) to 85.8 points (51-100), and from 9.4 points (5-20) to 29.6 points (25-30), respectively. MEPS significantly improved postoperatively from 39.0 (15-70) to 86.7 (65-100). Flexion/extension angle (deg.) significantly improved from 114.6 (45-160) /-44.6 (-90-0) to 134.6 (120-145) /-9.2 (-30-0). MMT of triceps was greater than 4 in all elbows except for 2 elbows of 1 patient of mutilans type. One intraoperative fracture and one heterotopic ossification occurred. There was no nerve injury or skin problem.

Discussion:

MIS-TEA was able to be performed in all cases including mutilans and ankylosis elbows, and satisfactory short-term results were obtained. Minimal invasion to the triceps enabled early postoperative exercise, which resulted in good postoperative muscle strength and ROM.

Poster: 259
#697

ORIF vs HHR for 3, 4 Part Proximal Humeral Fractures in Elderly Patients

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[Purpose]

The aim of this study was to compare the clinical outcomes of open reduction internal fixation by intramedullary nail (ORIF group) and humeral head replacement (HHR group).

[Materials and methods]

Twenty-six elderly patients who were over 65 year-old were followed more than 6months after 1998. In ORIF group, there were 17 shoulders (2 men, 15 women) and the averaged follow-up period was 20.5 months. In HHR group, there were 9 shoulders (1 man, 8 women) and the averaged follow-up period was 29.7 months. Five shoulders which were necrosis of humeral head were excluded. All patients were evaluated with the Modified-Neer classification, range of motion of flexion and external rotation, and complication.

[Results]

In Modified-Neer classification, one shoulder was classified as excellent, satisfactory in 13 shoulders and unsatisfactory in 2 shoulders in ORIF group, and no shoulder was classified as excellent, satisfactory in 2 shoulders and unsatisfactory in 7 shoulders. Postoperative flexion angle was 115.4 degrees in ORIF group and 87.9 degrees in HHR group. Postoperative external rotation angle was 30.5 degrees in ORIF group and 18.6 degrees in HHR group.

[Discussion]

ORIF group has a good clinical result rather than HHR group. ORIR was desirable if possible, however, when there was high risk of humeral head necrosis in elderly patiants, HHR must be chosen in Japan. When reverse shoulder arthroplasty is introduced in Japan, indication for proximal humeral fractures which have high risk of humeral head necrosis in elderly patiants.

Poster: 260
#872

Design Rationale and Clinical Evaluation of Total Knee Arthroplasty Reproducing Anatomic Geometry for Asian With Vitamin-E Blended UHMWPE

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Aims:

Total knee arthroplasty (TKA) has been generalized as an operation that achieves excellent clinical results. However, younger and Asian patients require even greater implant longevity and functional performance, especially deep knee flexion to sit on the floor. We hypothesized a novel TKA design that restores the anatomical jointline in both sagittal and coronal planes, maintains the femoral posterior condylar offset, and provides anti-aging material would provide enhanced patient function with the potential for greater implant longevity, refer to as the FINE® Total Knee System (FINE-TKA) was constructed [Fig.1]. The FINE-TKA was created based on geometry determined from anatomic specimens, 3-degree step of femorotibial jointline and an asymmetrical design of the femoral condyle and the tibial plateau were incorporated in the TKA design, the tibial insert was made of

ultra-high molecular weight polyethylene (UHMWPE) that was blended with an antioxidant, vitamin E (dl-α-tocopherol), followed by molding using the direct compression mold method, refer to as the BLEND-E®.

Methods:

We measured antero-posterior/medial-lateral ratio (aspect ratio) both femoral condyle and tibial plateau. The kinematic evaluation after TKA was performed using a 3D-to-2D model registration technique during kneeling activity with both weight and without weight bearing. The contact points between the tibiofemoral motions and the tibial rotational angle were evaluated.

Results:

Aspect ratio showed 0.87 of the femoral condyle, 0.67 of the tibial plateau. Kinematic analysis revealed an average 16.9 degrees tibial internal rotation with flexion to 90 degrees during kneeling with weight bearing. Condylar translations exhibited a medial pivot pattern from 0 to 90 degrees of flexion, with an average of 0.9 mm anterior translation of the medial condyle and 9.0 mm posterior translation of the lateral condyle with weight bearing.ã��In every case, FINE TKA showed tibial internal rotation with the medial pivot pattern. Short term clinical results for FINE TKA with vitamin-E blended UHMWPE are excellent, as well or better compared to FINE TKA with conventional UHMWPE.

Conclusions:

FINE-TKA based on restoration of articular surface orientation and bony geometry exhibits in vivo kinematics and alignment, contact mechanics that are compatible with excellent functional performance and implant longevity for Asian. Inclusion of vitamin-E blended UHMWPE may prolong the durable period in clinical use. Therefore, we believe that the FINE-TKA with vitamin-E blended UHMWPE will contribute to improve QOL of Asian.

Figures

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Figure 2

Poster: 261

#471

Does a Taper-Slip Stem With Cement Protect the Cement-Bone Interface in Hybrid Total Hip Arthroplasty ?

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(Introduction)

Cemented stem has been widely used in total hip arthroplasty (THA) since 1960's. Many literatures reported about the clinical and the radiological results of various cemented stems. Recently, it has been reported that the result of a taper-slip stem showed excellent and stable, however, that of a composite-beam stem.could be inconsistent. The purpose of this study was to compare the clinical and the radiological results between taper-slip stem and composite-beam stem.

(Materials and Methods)

We examined retrospectively 248 primary THAs with cemented stem. Charnley Elite Plus stem (composite-beam type) was used in 121 THAs and Exeter stem (taper-slip type) in 127 THAs. All 248 stem were implanted with third-generation cementing technique. The preoperative diagnosis was osteoarthritis in 226 joints, idiopathic osteonecrosis of femoral head in 16, and rheumatoid arthritis in 6. There were 212 joints in 202 women and 33 joints in 31 men. The mean age at THA was 64.9 years. The mean follow-up period was 6.5 years.

We investigated the clinical results, the radiological findings, and any complications.

Aseptic loosening of the stem was defined as Harris's criteria.

(Results)

Clinically, the Japanese orthopaedic association hip score improved; 35.1 points preoperatively to 86.3 points at the final follow-up. Revision surgery was performed 2 THAs with Charnley Elite Plus stem. One of them was for aseptic loosening of the stem, another one was for recurrent dislocation.

Radiologically, radiolucent line was more frequently found on proximal part in Charnley Elite Plus stem (46.3% on zone1 by Gruen , 26.4% on zone 7). On the other hand, it was much less in Exeter stem (1.6% on zone 1, 1.6% on zone 7).

One of the radiological features of Exeter stem was a subsidence of the stem in the cement mantle. It has been progressing year by year. (The mean subsidence was 0.65mm 1 year after surgery, 0.85mm after 2 years, 0.94mm after 3 years, and 0.96mm after 4 years). None of Charnley Elite Plus stem demonstrated any subsidence of the stem in 119 radiologically stable joints.

Definite loosening was found on 2 THAs with Charnley Elite Plus stem.

(Discussions and Conclusions)

The survival rate of Exeter stem (taper-slip type) was better than Charnley Elite Plus stem (composite-beam type) in short-term results. The radiological findings that there were less radiolucent lines in proximal region with Exeter stem would lead to a better long-term result.

We suggested that the subsidence of the Exeter stem in the cement mantle could act the compression force on the cement-bone interface and lead to protect cement-bone interface resulting in less appearance of radiolucent line compared with Charnley Elite Plus stem.

Poster: 262
#588

Excellent Results of Uncemented Polyethylene Patella - Minimum 10-Year Follow-Up-

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Several studies have reported the excellent results of cemented patella in the long-term follow-up. Metal-backed patellar components were used in uncemented total knee arthroplasty and caused exposure of the underlying metal backing and metal-on metal wear. Therefore, the application of uncemnted patellar component is not common. The purpose of the current study was to report a 10 - 16.7 year follow-up of 111 uncemented inset polyethylene patella The crucitae-retaining total knee prostheses (Hi-tech knee II) were implanted in 91 patients (mean age , 63.5 ±9.8 years). The femoral and tibial components were made of titanium alloy. A direct compression molded polyethylene with calcium stearate was applied to the insert and patella. The prosthesis design of the tibial insert was substantially flat in the sagittal and coronal planes. The femoral, tibial, and inset patellar components were fixed without cement. The primary diagnosis was osteoarthritis in 68 knees and rheumatoid arthritis in 43 knees. Eleven cases were men, and 80 ones were women. The Average Knee Society score (10-13 years) were 89.1 (clinical) and 72.1 (functional). There were four failures (1 supracondylar fracture, 2 heterotopic ossifications and 1 unstable knee). There were no cases of measurable polyethylene wear; neither of patella loosening. Cumulative survivorship was 99.1% after 10 years using revision as endpoint. A polyethylene insert was changed to the thicker one in the unstable knee. However, there were no revisions of patellar components. At minimum ten-year follow-up, uncemented inset polyethylene patellae demonstrated excellent clinical and radiographic results.

Poster: 263
#599

Relationship Among Preoperative Rom, Intercondylar Osteophytes and Cruciate Ligaments in Osteoarthritic Knee

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Newer prosthetic total knee arthroplasty (Bi-Cruciates Sparing TKA) designs as well as unicondylar TKAs spare the anterior cruciate ligament (ACL). Although success of these procedures requires near normal ACL function, little has been written about the arthritic ACL. This study was designed to evaluate the relationship among ROM, cross sections of the intercondylar notch and the macroscopic condition of ACL degeneration. Fifty osteoarthritic patients who underwent TKA as a result of severe osteoarthritis were randomly selected. Occupation rate of the osteophytes to the notch width were measured at the anterior 1/3, middle 1/3, and posterior 1/3 notche images obtained from preoperative tunnel view. ROM was measured preoperatively and under anesthesia. Macroscopic conditions of the ACL and PCL were classified into four types of Normal, Frayed, Partial rupture, and Absent.

The macroscopic ACL conditions were Normal: 12 cases, Frayed: 15 cases, Partial rupture: 14 cases, and Absent: 9 cases. The macroscopic PCL conditions were Normal: 34 cases, Frayed: 9 cases, Partial rupture: 7 cases, and Absent: 0 case. Occupation rate of the osteophytes to the notch correlated to the preoperative varus deformity ($p<0.05$). In terms of ACL, the occupation rate of the osteophytes to the notch were 22.9%, 28.8%, 46.0%, and 81.8% in Normal, Frayed, partial ruptured, and Absent, respectively. The patients with more than 40% occupation rate and less than 110 degree of knee flexion angle showed either partial rupture or absent of the ACL during the surgery.

We conclude that occupation rate of the osteophytes to the notch and poor preoperative ROM are a good predictor of evaluating the ACL degeneration in osteoarthritic knee. These preoperative information may help to select a patient for BCR TKA or UKA.

Poster: 264
#595

MRI Analysis of PCL During Knee Flexion: Comparison Between Normal and ACL-Deficient Knee

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Background:

In the normal knee, the posterior cruciate ligament (PCL) resists posterior displacement of the tibia and plays an important role in femoral roll-back during flexion. However, whether PCL functions effectively in cruciate-retaining total knee arthroplasty (CR-TKA) remains unclear. The purpose of this study is to investigate PCL movement during anterior cruciate ligament (ACL) deficient knee flexion using magnetic resonance imaging (MRI).

Methods:

Eight subjects with no history of knee injury and 7 subjects with ACL injured knee were enrolled in this study. The mean age of the patients with normal knee and ACL-deficient knee was 25.8 and 33.4, respectively. MRI was performed in each knee at knee flexion of 0°, 30°, 60°, and 90°. The angle between PCL and tibial articular surface (PCL angle), distance between femoral and tibial attachments of PCL (PCL length), and posterior translation of the medial femoral condyle and the lateral femoral condyle from the midpoint of the tibial articular surface in sagittal plane (AP-MFC and AP-LFC) were investigated.

Results:

PCL angles (ACL deficient/normal knee) at knee flexion of 0°, 30°, 60°, and 90° were 45.4°/44.1°, 47.1°/43.8°, 51.0°/51.8°, and 64.3°/60.8°, respectively. For the corresponding angles, PCL lengths were 32.3 mm/36.5 mm, 39.1 mm/41.5 mm, 40.4 mm/43.4 mm, and 41.1 mm/45.6 mm; AP-MFC were 5.9 mm/4.9 mm, 5.8 mm/5.6 mm, 6.6 mm/4.4 mm, and 6.0 mm/4.5 mm; and AP-LFC were 6.2 mm/1.4 mm, 3.6 mm/1.7 mm, 4.3 mm/2.3 mm, and 6.8 mm/6.7 mm. PCL angles and PCL lengths were increased as knee flexion in both groups. These results

indicated that there were some PCL functions during knee flexion even in ACL deficient knees. On the other hand, PCL angles in ACL deficient knees were relatively larger than normal knees at 30° and 90° degree, but there were no significant differences between two groups. PCL lengths in ACL-deficient knees were relatively shorter than that in normal knees throughout knee flexion. AP-MFC and AP-LFC in ACL-deficient knees were relatively larger than those in normal knees but there was no significant difference between them. To function PCL, PCL must have enough tension and there should be some distraction forces between the femur and the tibia. If there was enough distraction force in ACL deficient knees, PCL angles were expected to be larger than normal knees by anterior movement of the tibia. However, our results showed that PCL angles in ACL deficient knees were almost same as in normal knees and PCL lengths in ACL deficient knees were shorter than those in normal knees. These results indicate there was not enough distraction force between the femur and the tibia.

Conclusion:

PCL movement during knee flexion was investigated in ACL deficient and normal knees. It is considered that PCL worked to some degree during knee flexion in ACL deficient knees, but the function was not enough. It should be considered that flexion gap might become larger and appropriate distraction force (thickness of polyethylene insert) between the femur and the tibia would be necessary for an adequate PCL function in CR-TKA.

Poster: 265
#491

Clinical Results of the Cemented Titanium THA Stem With Double-Tapered Design -Comparison With the Results of the Cylindrical Tip Stem

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[Introduction]

We have compared the clinical results of the K-MAX HS-3 tapered stem with those of the previous type having cylindrical tip.

[Materials and Methods]

In K-MAX HS-3 THA (JMM, Japan), cemented titanium alloy stem and all polyethylene cemented socket are used. This stem has the double tapered symmetrical stem design, allowing the rotational stability and uniform stress distribution (Type T) (Fig. 1). The features of this stem are; 1. Vanadium-free high-strength titanium alloy (Ti-15Mo-5Zr-3Al), 2. Double-tapered design, 3. Smooth surface (Ra 0.4μm), 4. Broad proximal profile, 5. Small collar. In contrast, previous type stem has the design with cylindrical stem tip, allowing the maximum filling of the femoral canal (Type C) (Fig. 2). Osteolysis at the distal end of the stem had been reported in a few cases in Type C, probably due to the local stress concentration. Therefore the tapered stem was designed, expecting better clinical results.

All surgery was performed at Kitano Hospital between September 2003 and September 2005. 60 THA were performed (Type T; 40 hips, Type C; 20 hips). The average age of the patients at the operation was 64 and 70 years and the average follow-up period was 5.9 and 6.2 years for the Type T and C, respectively. The all-polyethylene socket was fixed by bone cement, and the femoral head material was alumina or CoCr (22 or 26 mm).

[Results]

One hip was revised in Type C. Japanese orthopaedic association (JOA) score improved from 40/37 to 84/77 points (Type T/C). Postoperative complication was dislocation in two cases (Type C; 1, Type T; 1). Socket loosening was not observed radiographically. Stem loosening was observed in one hip in Type C, demonstrating osteolysis at the distal end of the stem. In this case revision THA was performed 3.5 years postoperatively. Bone resorption was more frequently observed in Type C than Type T. Cortical hypertrophy was observed in 7.5% in Type T and 25% in Type C.

[Discussion]

The short-term clinical results of K-MAX HS-3 taper stem (Type T) was satisfactory. The osteolysis at the stem tip was not observed in this type, which was observed in a few cases in previous Type C. From the X-ray finding, it was suggested that Type T had more uniform stress distribution to the femoral bone than Type C. Moreover, the problems associated with titanium alloy usage were not observed. From the present investigation, the better long term results of the tapered titanium stem (Type T) was expected.

Figures

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Figure 1 HYPERLINK "http://app.istaonline.org/figures/457.jpg" \t "_blank"
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Figure 2

Poster: 266
#489

Failure Criterion of Polyethylene Insert of a Knee Prosthesis

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Failure criteria of ultra-high molecular weight polyethylene (UHMWPE) should be clarified for the strength design of joint prostheses. In the present study, we performed compression tests of UHMWPE plates together with finite element (FE) analysis under conditions similar to those within a total knee prosthesis and discuss the failure criteria.

Flat plates made of conventional or cross linked UHMWPE were molded as test pieces. Those thicknesses were ranging from 2 mm to 8 mm. The compression test using a loading machine was performed in a bath filled with saline solution at 37 degrees centigrade. A metallic sphere 50 mm in diameter was used for the indenter. The load was applied to 6 kN under a crosshead speed of 60 mm per minute. Flow pressure was calculated after the test as a ratio of the impressio area and the maximum load. Deformation of the plate was estimated by displacement at the edge. Additionally, the FE analysis was performed on a virtual model using the same conditions as in the experiments.

The values of the flow pressure were measured as a mean of 47.0 MPa, SD 2.0 MPa for conventional UHMWPE, and as a mean of 58.4 MPa, SD 3.5 MPa for cross-linked UHMWPE. The displacement of the UHMWPE plate increased with decreasing thickness of the plate. The displacement estimated by FE analysis was similar to that of the experimental findings. Furthermore, shear strain in the UHMWPE plate of FE model increased with the displacement. It was concluded that the failure criteria of joint prostheses must be presented by not only the stress but also the strain in a UHMWPE insert. In the plastic design of the polyethylene insert of the total knee prosthesis, it has been understood to make 0.3 of the maximum shear strains generated in UHMWPE in the size a strength criterion.

Poster: 267
#515

The Relationship Between the Size of Femoral Implant With Lateral Flare and the Morphology of the Proximal Femur

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Introduction

We have been performed uncemented THA using Revelation stem®(DJO,USA) with a lateral flare which produced proximal load transfer. Although preoperative planning was performed using 3D femoral models, in some cases the different size of femoral implant from preoperative planning was selected. The purpose of this study was to investigate that the parameter at which level in proximal femur had correlated with the size of femoral implant by measuring the width of each level in proximal femur using 3D femoral models to obtain a higher accuracy of preoperative planning.

Materials and Methods

40 THAs in 36 patients (6 male 7 hips, 30 female 33 hips, average age 64.0 years old) performed in our institution using Revelation stem were included in this study. Patients background were osteoarthritis in 35 hips, avascular necrosis in 5 hips. The size of femoral implant inserted was 9.0 in 6 hips, 10.5 in 21 hips, 12 in 9 hips, 13.5 in 4 hips. From CT data 3-D femoral models were created by using the software, Mimics and Magics(Materialize, Belgium). Mimics was used to transfer CAT scan data to CAD data (STL). Using Magics, those CAD data were observed and assessed in 3-D space. The proximal femoral extracortical and canal width (+20mm, +10mm, -10mm, -20mm from the center of lessor trochanter), isthmus extracortical and canal width were measured. In addition, CFI, Femoral Flare index(the ratio of the ratio of proximal extracortical femoral M-L width and isthmus extracortical M-L width) were calculated. The relationship between each parameter and the size of femoral implant was investigated retrospectively.

Results

As the size of the inserted femoral implant was larger, medio-lateral canal width of each level in proximal femur was wider. However, the parameter correlated with the size of femoral implant was anteroposterior extracortical isthmus width.

Discussion

There were some considerations that anteroposterior extracortical isthmus width were correlated with the inserted implant size. About proximal femoral parameter, at which the occupation of cortical bone was low compared with isthmus, it was not affected by osteoporosis and determined by femoral size and deformity. At isthmus canal, leaming was needed to avoid proximal stress shielding and distal load transfer intraoperatively in some cases of which isthmus had thicker cortex and narrower canal that was not to be affected by osteoporosis. On the other hand, the extracortical isthmus width which did not have an effect of operation was proper to the femoral size. Therefore it was thought to be a reason the extracortical isthmus width was correlated with the size of femoral implant. To conclude, there was a possibility that the measurement of isthmus extracortical width contributed to a preoperative planning for the selection of the size of femoral implant from this study.

Poster: 268
#433

Knee Arthroplasty With Rotating Hinge Prosthesis in Patients With Poliomyelitis

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Introduction.

Even if Acute Anterior Poliomyelitis (AAP) has become a rare disease in most western Countries, currently many people are affected by deformities following this disease. Total knee arthroplasty (TKA) with unconstrained or semiconstrained prostheses in limbs affected by poliomyelitis has resulted in good pain relief, but concerns have been raised regarding recurrence of knee instability. The issue of whether to use constrained implants during knee arthroplasty in patients with AAP is still debated due to increased stress transfer to the fixation interface and subsequently potential loosening of more constrained implant.

Materials and methods.
Between February 2004 and January 2010, we performed 14 consecutive TKAs in patients affected by knee osteoarthritis following poliomyelitis. All patients had less than antigravitary quadriceps strength and in all cases was used rotating hinge prosthesis (RHK, Zimmer, Warsaw, Ind, USA). Mean age at surgery was 56 years (range 48 to 77 years), one patient was operated in both knees. All patients were evaluated both clinically and radiographically.

Results.
Patients were followed for a mean of 32 months (range 14 to 85 months); one patient required revision five months after surgery for prosthesis infection. Another patient reported patella fracture in involved knee after fall, that healed completely with conservative treatment. All other patients reported excellent pain relief without complications.
At final follow-up there were no radiological signs of implants loosening [Fig. 1,2]. American Knee Society objective score improved postoperatively from 28 point mean (range 16 to 51 points) to 79 points (range 72 to 88 points) postoperatively. Functional score too increased from a mean of 29 points (range 20 to 45 points) to 56 points (range 55 to 65 points). Mean range of motion at final follow-up was 90° (range 75° to 100°).

Discussion.
We consider rotating hinge prosthesis to be suited for the treatment of patients with history of poliomyelitis and less than antigravitary quadriceps strength. In our opinion much of the past criticism about increased stress transfer to the fixation interface in hinged prostheses is no longer justifiable: early hinged knee devices are now replaced by modern rotating hinge prostheses that allow more physiological kinematics by a better distribution of the shearing forces. From a technical point of view the rationale to use that type of prosthesis is connected with its intrinsic stability on the different planes, but also on allowing a slight hyperextension of the knee [Fig. 3], thus ensuring less functional deterioration.

Figures
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Figure 3
Poster: 269
#434

Trabecular Metal Cones for Severe Bone Defect in Knee Revision Arthroplasty

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Introduction.

Porous tantalum is a new biomaterial currently available for use in several orthopedic applications due to its favourable mechanical and biological characteristics. Tantalum-made augments in a block and wedge fashion are useful in managing small amounts of femoral or tibial bone loss. Nevertheless, to compensate for larger bone defect involving metaphyseal segment or major portion of the condyle or plateau [Fig.1], tantalum cones have been developed (TMT, Zimmer, Warsaw, Ind, US).

Matherials and methods.

We present our experience with femoral and tibial tantalum cones in 11 knees (12 cones overall were used, six on femur and six on tibia) during knee revision arthroplasty. Mean age at surgery was 62 years (range 43 to 75 years). Both cemented and cementless cones were used. Cementless, press-fit, intramedullary stems were used for both the tibial and femoral component in all patients but two; cemented stems were used in two patients to whom rotating hinge prosthesis was implanted. No intra-operative complications related to the implantation of the trabecular metal cones were observed whereas we have had a case of fracture of the medial femoral condyle which was fixed in place with one screw [Fig.2].

Results.

After a mean 30 months follow-up (range 12 to 56 months) patients were evaluated clinically and radiographically. Total knee score improved significantly from a mean of 42 points (range 25 to 56 points) to 69 points (range 51 to 93 points); functional score improved too, from a mean of 14 points (range 0 to 25 points) to 69 points (range 45 to 90 points). Radiological analysis showed no cases of aseptic loosening or migration of the components. The only reported post-operative complication was delayed union of the tibial tuberosity in a patient who required osteotomy for surgical exposure.

Discussion.

The results of this study supports use of porous tantalum femoral and tibial metaphyseal cones as a viable option for revision knee arthroplasty with large amount of bone defects in both femur and tibia. Compared with preparation of a structural bone allograft, TMT metaphyseal cones required simpler surgical technique for implantation, resulting perhaps in shorter operative times with a potential beneï¬t of a decreased infection risk.

Figures

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Figure 2

Poster: 270
#648

GMRS Knee Megaprosthesis in the Treatment of Complicances of Complex Distal Femur Fractures

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Introduction

Most of the fractures of the distal femur can be treated successfully with modern methods of synthesis. Occasionally however, there may be non-union, non-union with vicious consolidations or, more commonly in

patients with poor bone quality or complex fractures, with outcomes often complex. Options for the recovery of such frameworks include a second open reduction and resynthesis, arthrodesis or knee replacement. For younger patients with articular cartilage preserved and residual bone stock suitable for the synthesis, open reduction and internal fixation (ORIF) is usually the option of choice. For elderly patients with severe osteopenia, who already undergone several unsuccessful attempts of internal fixation, poor bone stock and/or severe degenerative changes of the knee and in younger patients with severe injuries of the joint, the prosthesis can be a viable alternative. The purpose of this study is to examine a limited number of consecutive patients with failure of internal fixation or nonunion of the distal femur recovered whith knee megaprosthesis GMRS to evaluate results and complications associated with the procedure.

Methods

We retrospectively reviewed five patients treated with knee,megaprosthesis GMRS, the mean age was 62.5 years (range 38-84), 3 females and 2 males, follow up of more than two years, in 3 cases were results of supra-condylar fracture treated with plate and screws, a case of peri-prosthetic fracture, a nonunion after treatment with external fixator with spontaneous joint fusion.

Results

The results were evaluated by IKS. IKS increased from a preoperative average of 24.4 (range 20-32) in postoperative mean 84 (range 80-90). In all cases there was complete or nearly complete resolution of preoperative pain. There were no major complications.

Conclusions

Despite the difficulties associated with a technically demanding option, in all patients there was pain relief and significant functional improvement. Duration and functional results were slightly lower than those reported for primary total knee replacement for other diagnoses. The use of megaprosthesis in selected cases of results of failed osteosynthesis of fractures of the distal femur is considered a very viable alternative, where a new osteosynthesis is not possible or co-occurs a degeneration of the knee joint, especially in elderly patients who need a more rapid recovery of ambulation and functional recovery.

Poster: 271
#715

Third Generation Alumina-on-Alumina Ceramic Bearings in Cementless Total Hip Arthroplasty in Patients 55 Years and Younger: A 10 Year Follow-Up.

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AIM

Alumina ceramic on ceramic bearings in total hip arthroplasty (THA) may reduce the prevalence of osteolysis due to its properties of low wear and chemical inertness. This is critical in the younger patient population as they place increased demands over a longer period. This study reports on the clinical and radiographic outcomes of a series of modern cementless ceramic on ceramic THA at a minimum of 10 years in this younger group.

METHOD

A series of 120 consecutive third generation ceramic cementless THA were performed at a single centre in 110 patients from 1997 to 1999. The average age of the patients at the time of surgery was 45 years (20 to 55 years). All procedures were carried out via the posterior approach using the same implant by the two senior authors.

RESULTS

At 10 years, 4 patients had died and 6 were lost to follow-up (5%). The mean Harris Hip Score was 94.7 points. All surviving implants analysed radiographically had evidence of stable bony ingrowth, with no cases of osteolysis. Wear rates were undetectable. There were 3 revisions (2.5%). One stem was revised following periprosthetic fracture, one stem was revised to facilitate a femoral shortening osteotomy. One cup was revised for

anterior impingement causing psoas tendonitis. There was one incident of intraoperative ceramic liner chipping, which was changed without complication. There were no postoperative bearing fractures. Two patients reported intermittent squeaking at extreme hip flexion and internal rotation, the hips otherwise functioned well. The survival for both components with revision for any cause was 97.5%

CONCLUSION

Alumina ceramic on ceramic bearings in cementless primary THA in this series have resulted in good clinical and radiographic outcomes with low wear rates and excellent function in the demanding younger patient group at 10 years.

Poster: 272
#563

In-Vivo Kinematics Analysis and Prosthetic Component Positioning in Total Ankle Replacement

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INTRODUCTION

An original three-part total ankle replacement (TAR) design was developed to establish full compatibility between the shape of articulating surfaces and the retained ligaments throughout the flexion arc. This was achieved with a convex spherical tibial and a talar component with a radius of curvature in the sagittal plane longer than that of the natural talus, unlike most of the current three-part designs. A fully conforming meniscal bearing is interposed and it is supposed to move backwards/forwards on both metal components during plantar-/dorsi- flexion. This design followed mathematical model predictions from measurements on specimens in virtually unloaded conditions. Because of these claims, a normal kinematics should be restored at the replaced ankle, and at the same time, the appropriate positioning of the components during surgery is recommended. The aim of this study is therefore to assess whether the design claims are met in patients during activities, and whether the prosthesis implantation can affect these claims at the replaced joint.

MATERIAL AND METHODS

Twelve patients implanted with the BOX Ankle TAR (Finsbury Orthopaedics, Leatherhead-Surrey, UK) were analyzed. In static double leg stance, pre- and post- operative X-ray pictures were acquired in antero-posterior with the ankle in neutral position, and in lateral projection with the ankle in neutral, maximum plantar- and dorsi-flexion positions. All radiographs were digitally stored and relevant images analyzed on-screen by original computer-based procedures. These patients were also analyzed using a standard fluoroscope (CAT Medical system, Rome, IT) at 10 Hz, during flexion against gravity and stair ascending/descending. Post-operative follow-ups (FUs) were performed at 6, 12, and 24 months. Reference frames for the three prosthesis components were defined onto the corresponding CAD models. Three-dimensional component positions and orientations were obtained from each image by an iterative procedure which allows the best alignment (0.5 mm/1.0° accuracy) between prosthetic CAD model and relative visible contour of the silhouette.

RESULTS

On average, in static double leg stance, the range of motion at the replaced ankle were respectively 32.8°, 32.2° and 31.4° at the FUs, and couple to 3.8, 3.2, and 3.3 mm antero-posterior meniscal-to-tibial motion ($p<0.05$). This coupling occurred also in flexion against gravity and stair climbing/descending ($p<0.05$). Tibial and talar components were slightly more anterior than the mid-tibial shaft in 11 and 9 patients, respectively. Mean inclination was about 4° posterior for the tibial component, nearly 1° anterior for the talar component. Varus-

valgus deformity post-operative was less than 5.0° in all ankles, range pre-operative being 0.1 - 23.5°. These geometrical parameters were not correlated with the meniscal-motion.

DISCUSSION

A good ankle joint mobility, already at 6 months and maintained at FUs was achieved. The considerable meniscal-to-tibial motion and its coupling with flexion, revealed that natural motion is restored at the replaced joint according to the original biomechanical design. Accurate implant component positions and deformity correction were observed, demonstrating also that surgical technique does not affect critically the claims of this design. In the future, for improving the functional assessment, the combination between fluoroscopic and traditional gait analyses will be provided.

Poster: 273
#729

Clinical Results of Transtrochanteric Rotational Osteotomy for Idiopathic Osteonecrosis of the Femoral Head

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Abstract

Objective:

As idiopathic osteonecrosis of the femoral head (ION) frequently develops during young adults, joint preserving surgery is important. We retrospectively reviewed the clinical and radiographic results in whom we performed transtrochanteric rotational osteotomy of femoral head over 5-year period.

Method:

We were able to follow 32 consecutive patients (25 males and 7 females, 38 hips) for a mean of 13.5 years. The average age was 37.7 years at the time of surgery. The ION stage was 2 in 1 joint, 3A 24 joints, 3B 13 joints in terms of classification by the Japanese Organizing Committee classification. The necrotic type was C-1 in 6 joints, C-2 in 32 joints as per the Japanese Organizing Committee classification. We evaluated them by means of the Japanese Orthopaedic Association Score (JOA score) and radiographic analysis.

Results:

The mean JOA score improved from 54.7 to 86.6 points ($p<0.0001$) at the time of the final follow-up evaluation. Radiographically, the osteonecrosis in 26 hips (68%) had no progressive collapse, and 12 (32%) showed osteoarthritic changes and collapse. 6 patients (8hips) underwent THA. Postoperative intact area ratio (%) was significantly different between no progressive collapse (74.5%) and progressive collapse (45.4%) ($p<0.05$). The cumulative survival rate was 75.6% at 13 years, with conversion to THA as the end point.

Conclusion:

In cases of extensive lesions, adequate rotation and intentional varus position is important to prevent the collapse of the transposed necrotic area.

Poster: 274
#868

Micromechanical Behaviour of Bone-Cement Interface Under Compression

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Introduction

The lasting integrity of the bond between the bone and the cement is essential to the success and longevity of cemented total joint replacements. In the current study, compressive micromechanical behaviour of bovine bone-

cement interface specimens was studied using both experimental and FE approaches to evaluate micro damage evolution.

Materials and methods

Bovine trabecular bones were harvested from fresh iliac crest and used to bond with acrylic bone cement to create six bone-cement interface samples with dimensions of $10\times16\times5mm^3$. With a novel custom-made micro-mechanical loading stage, the specimens were step-wise compressed at two selected displacements, corresponding approximately to the ultimate apparent strength and just before the final failure (Fig.1). At each step the specimen was allowed to relax before CT imaging and data acquisition procedures were carried out.

The μCT images of a typical specimen were imported into Avizo 6.3 for three-dimensional reconstruction and FE mesh generation. The resulted bone-cement composite model, with a dimension of $8\times9\times4.4mm^3$, consisted of 2,506,235 elements and 571,756 nodes (Fig.2). The FE model was then imported to ABAQUS 6.9 for compressive analyses, assuming large deformation to account for geometrical nonlinearity. Four regions of interest were defined in the FE model to monitor the damage distribution and development with loading: Bone; bone and cement contact (BCC); bone and cement interdigitated (BCI) and cement region. The yielded bone and cement elements in these regions were recorded as a function of the applied displacement.

Results

The internal volume micro damage evolution in all six bone-cement interface specimens was recorded at each step of the step-wise compression tests. All the samples showed similar damage patterns where the predominant deformation was found to initiate and develop in the Bone and BCC regions, whereas the Cement region appeared to be largely unaffected. The main load transfer mechanism appeared to occur in the BCC region, resulting in progressive micro failures in a form of buckling of trabeculae in the proximity of cement pedicles, whereas no apparent bone-cement debonding or cement fracture was found in the fully interdigitated region (BCI). Fig.3 shows the predicted distribution of the yielded elements within the four regions under the selected compressive displacements. Yielding appears to initiate in the BCC region, in both the bone and the cement volumes. Under a 0.5 mm compression, the yielded bone volume was 7.9 mm^3, which is more than twice that of cement (3.0 mm^3). As the overall bone volume (41.4 mm^3) was lower than that of cement (146.3 mm^3), the difference in the percentage of yielded volumes between bone (19.1%) and cement (2.1%) is significant.

Conclusion

Both experiments and FE analysis show that bone failure appears to be mainly responsible for the bone-cement compressive interfacial failure. Load transfer mainly occurred in the bone cement contact region, resulting in progressive deformation due to mainly buckling of the trabeculae in the vicinity of the cement pedicles with no apparent debonding or cement fracture.

Fig. 1: a) A custom-made micro-mechanical loading stage within the μCT chamber; b) a schematic of the LS, which was used to apply the load in stepped compression.

Fig. 2: The finite element model of a bone-cement composite sample generated from the μCT images of the specimen.

Fig. 3: The predicted progressive development of yielded elements from the FE model under a compressive displacement of (a) 0.1mm and (b) 0.5mm. Yielding appears to initiate mainly in the Bone and the BCC regions, developing across the BCC and BCI regions. Red: Bone; blue: Cement.

Figures

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Figure 6
Poster: 275
#578

Mid-Term Result of Threaded Cup for Dysplastic Hips: A Combination of BICON-PLUS® Cup and SL-PLUS Stem® With Ceramic on Polyethylene Bearing Couple

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In Japan osteoarthritis secondary to hip dysplasia is the most common diagnosis for total hip arthroplasty. A dysplastic hip often has shallow and small acetabulum with poor bone quality, and thin and narrow femur. Even for such hips a good initial stability and an adequate implant position are essential. Uncemented thread cup has been used widely for primary osteoarthritis or aseptic necrosis and its related studies were well established especially in Europe. The non-cemented, threaded type acetabular fixation system had been adopted for a period to dysplastic hip in our institute.

Patients and Methods: Twenty-nine hips in 19 (17 women and 2 men) underwent the total hip replacement using the third-generation Zweymüller Hip System (BICON-PLUS Cup® and SL-PLUS Stem®, Smith & Nephew AG, Rotkreuz, Switzerland) with the ceramic on polyethylene bearing couple since July 2001 until August 2004. In all patients the diagnosis for the surgery was osteoarthritis due to hip dysplasia. Thirteen hips were Grade I in Crowe's Classification, 12 were Grade II, one was Grade III, and one was Grade IV. The mean age at the surgery was 73 (60 to 81). All surgeries were performed by two well-trained surgeons in our hospital. The mean follow-up period was 59 (3 to 110) months. Clinical evaluation was performed using Japanese Orthopaedic Association Hip Score and Trendelenburg Sign. The stability of implants and periprosthetic reaction were evaluated using the consecutive radiographs and the bone mineral density around the stem was analysed using the dual energy X-ray absorptiometry (DEXA) systems.

Results: The mean Hip Score was 48 (13 to 73) preoperatively and improved to 85 (67 to 96) at the final follow-up. Trendelenburg Sign was positive in two hips at the final follow-up. All stems were stable at the final follow-up. A migration occurred in one cup. The possible reason was that this cup had been threaded into the acetabulum excessively beyond the lamina interna during the surgery. Radiolucent line was observed around one cup (3.4%) and five stems (17.2%). Ectopic bone formation was detected in two hips. The DEXA revealed the bone mineral density decreased significantly in Gruen's Zone 1 (from 0.666 to 0.574 g/cm^2 $p<0.000$), Zone 6 (from 0.992 to 0.836 $p<0.000$), and Zone 7 (from 1.085 to 0.594, $p<0.000$) while increased significantly in Zone 2 (from 0.980 to 1.104, $p<0.000$, Zone 3 (from 1.300 to 1.586, $p<0.000$), Zone 4 (from 1.267 to 1.431, $p<0.000$) and Zone 5 (from 1.300 to 1.650, $p<0.000$). The existence of the radiolucent lines and the changes in bone mineral density had no significant relationship to the stability of the stem and to the clinical symptoms.

Conclusion: The use of this thread cup for dysplastic hip may be controversial. However, a combination of threaded BICON-PLUS® Cup and SL-PLUS Stem® with ceramic and polyethylene articulation couple had a good stability either cups or stems in this study. Thus, the threaded cup can be one of the possible options even for the dysplastic hips based on the careful surgical procedure.

Poster: 276
#419

Revision of Total Hip Arthroplasty Using Apatite for Massive Bone Defect of Acetabulum

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Introduction

Replenishing bone defect is an important factor in revision THA. Various methods have been to complement massive bone defects. In complementing bone defects, recovering bone stock is an important issue. In this study we used a large volume of HA to reconstruct acetabular and examined postoperative results of these operations.

Methods

From the patients who underwent THA at our hospital, we selected the study population that consisted of 12 patients(10 hips) whose acetabular showed a significant amount of bone defects in radiograph and who suffered sever pain. They were 2 men and 8 women with the mean age of 63(26-76). Eleven had osteoarthritis, one had

avascular necrosis of femoral head after traumatic injury. The mean observation period after revisions was 12.8years.Our operative methods was that we construct acetabular with a large amount of HA granules, and fixed cups with cement. For 5 patients we also used Kerboull Cross Plate as the inner layer. Three patients underwent revision of femoral side, too.

JOA score was used for clinical evaluation. A/P view in simple X-ray were used for radiographic evaluation. We examined following 3points.1.Collapse of HA,2.Coditions of bone formation in the inter face of the bone bed and HA,3.Loosening and displacement of the cups.

Results

JOA score improved from preoperative mean score of 51 to the mean score of 67 at the time of our examination. In the radiographic evaluation, bone formation was observed after about 3months.After about 1yearthe interface of the bone and HA was incorporated. After the incorporation, we did not observe any changes on X-Ray images. Collapse of HA and displacement of cups were not observed during 9.3years.

Discussion

In revision THA on acetabular with bone defects, autologous bone, HA, allogeneic bone, Kerboull and large cups can be used to complement the defects. But, considering the quality, quantity and infection problems, HA is effective in massive bone defects. Initial fixation and collapse by load bearing were our conventional concern when HA only was used in a surgery. But as such problems were not observed in our investigation, we assume that the use of HA is effective.

Poster: 277
#755

Validation of Finite Element Models of UKR

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Introduction

Due to the increasing demands imposed on knee arthroplasty, particularly with younger and more active patients, Unicompartmental Knee Replacements (UKRs) are an attractive option. However, UKR revision rates are higher than those of Total Knee Replacement, with component loosening as a major cause. Although clinical studies have provided insight into fixation outcomes, the results are inconclusive due to the confounding factors. Computer models can provide a different perspective on understanding implant fixation, provided the results are credible. Finite Element (FE) models have been developed to predict bone-implant micromotion and bone strains induced by cemented and cementless UKR implants. Sensitivity assessments were conducted to understand the effects of uncertainty of input parameters. Multi-specimen in-vitro mechanical experiments were used to validate the models and a follow-up in-vivo DXA study is underway to validate long-term bone remodelling predictions.

Methods

FE models of the tibia were developed from Computed Tomography (CT) scans of UKR patients and cadaveric knees. Elastic moduli were assigned on an element-by-element basis, estimated from CT data based on CT-to-density and density-to-elastic-modulus relationships. Forces for tibio-femoral contact, muscle tendons and ligaments, during walking and stair climbing activities were simulated. Bone-implant micromotions were resolved into normal and transverse components and bone strains were assessed against their strain failure limits.

Sensitivity assessments of uncertainty of material properties and knee forces published the literature were investigated. Ten different combinations of density-to-elastic-modulus relationships were tested.

To validate the models, ten fresh frozen cadaveric knees were implanted with cementless medial Oxford mobile UKRs, the tibias and femurs were separated and all the soft tissues were resected. Five strain gauge rosettes were attached to each tibia. Linear transducers were used to measure the superior-inferior and transverse bone-implant micromotions. The cementless UKRs were assessed with 10 cycles of 1kN compressive load at four different bearing positions. The bone-constructs were re-assessed following implantation of the cemented versions of the implants.

Results and Discussion

The sensitivity assessments revealed a large discrepancy for the cancellous bone density range. Some of the published material property relationships led to predictions of bone strains which exceeded published failure criteria under loads imposed by normal activities. Material properties derived from humans and specific to the tibia produced the most accurate predictions. The patellar tendon and anterior cruciate ligament forces had a large effect on the strains in the vicinity of the implant; therefore, it is important to include these in UKR models.

The results of the in-vitro experiments showed large inter-specimen variation of bone strains and micromotion and highlighted the importance of a multi-cadaver validation. There was a statistically significant difference between cemented and cementless implants, with higher bone strains in cemented implants and higher micromotions in cementless implants. The average minimum principal bone strain for cementless and cemented implants was 650 $\mu\epsilon$ and 550 $\mu\epsilon$, respectively. For cementless implants, the transverse micromotions were less than 100 μm which should allow good osseointegration. However, the superior-inferior micromotions were higher (0-300 μm).

Work supported by the Arthritis Research UK Charity.

Poster: 278
#1027

Initial Results From a Novel Multidirectional Lift-Off Type Aseptic Wear Simulation Device

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INTRODUCTION:

Implant generated ultra high molecular weight polyethylene (UHMWPE) wear particles have been shown to initiate macrophage-mediated inflammation that can lead to bone resorption at the implant interface[1]. Attempts to characterize the biological response of UHMWPE wear debris have sometimes involved the use of either manufactured particles or non-clinically relevant wear conditions[2,3]. However, Teramura et al reported on the bioactivity of Vitamin E (VE) Blended UHMWPE wear particles produced aseptically using a pin-on-plate wear apparatus[4]. This paper introduces a wear simulation device that is similarly capable of producing aseptic wear debris, but unique in its construction and operation. The preliminary results from the use of this device are provided along with a detailed description of the device itself.

MATERIALS & METHODS:

The simulator is composed of three separate, sterilizable test chambers that are housed within a larger, temperature controlled unit, as shown in Figure 1. The bottom half of each chamber slots into a movable stage controlled by two linear actuators, while the upper half connects to a horizontally stationary, pulley apparatus. When in motion, the two halves of the test chamber are connected by an accordion shaped silicone jacket that protects against contamination and allows relative motion between the two chambers. The upper chamber is also able to move vertically, allowing it to 'lift off' during experimentation.

For testing, three pins each of Virgin and VE Blended UHMWPE (0.3%v/v) were evaluated against roughened CoCr plates (Ra~1 μm) under a nominal contact pressure of 6.94 MPa, moving in a quadrilateral pattern. All simulations were performed in a 25% (v/v) bovine serum lubricant at 37°C. Neither antibiotics nor sodium azide were added to the lubricant. Following testing, the lubricant was collected, with a small portion used to test for bacterial contamination. Pins were massed before and after to calculate the amount of wear debris generated. Wear particles are now being analyzed with regard to shape and size.

RESULTS:

As can be seen in Figure 3A, a greater amount of wear debris was generated from the VE Blended pins than from the Virgin pins. Also, after looking at the contamination results (3 of the 6 stations were contaminated), it was noticed that there was a difference in mass loss between the contaminated and uncontaminated samples, irrespective of material, as seen in Figure 3B. The significance of this difference was confirmed using the Wilcoxon Rank Sum Test with a confidence limit of 0.95 and no continuity correction.

DISCUSSION & CONCLUSIONS:

The wear simulation device described was successfully used to create an aseptic environment in which to test potential artificial joint materials. As the contamination tests revealed, the aseptic condition of any wear simulator has a significant effect on the wear debris produced. However, the contamination tests also revealed that there are still some issues with the device that need to be addressed. The main problem appears to be the silicone jacket, which has several limitations. Thus, for future development, these issues will need to be addressed.

Figures

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Figure 3

Poster: 279
#898

Automated Extraction of the Femoral Anatomical Axis for Planning Intramedullary Rod Alignment.

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INTRODUCTION

Advances in computer technology and medical imaging have contributed to new patient-specific approaches for total knee arthroplasty (TKA). 3D images are increasingly being used for preoperative planning. However, prosthesis position and limb alignment are currently determined by manual analysis, which is time-consuming, requires expertise, and is characterized by observer variability. Furthermore, navigation systems and patient-specific guides have shown to improve the accuracy of prosthesis positioning, but long-term studies are needed to evaluate clinical outcome and benefits. Conventional instruments, such as femoral intramedullary rods (FIR), are still commonly used, but may lack accuracy due to errors in the entry point location and especially require a thorough planning if anatomical variations, such as excessive bowing and capacious medullary canals, are present. Therefore, an automated approach for preoperative planning of FIR insertion is proposed.

MATERIALS & METHODS

In this study, the FIR orientation and entry point are determined from a 3D model (triangular surface mesh) of the femur. The femur is first oriented in a standardised way. Next, the straight middle diaphysis axis (FMDA) is computed by fitting an elliptic cylinder to the middle shaft. Then, a series of elliptic hyperboloids is fitted to the diaphysis to extract the anatomical axis (FAA). The FAA is represented by a 3D Bezier curve and its endpoints are found by limiting the radius change of the diaphysis to 10%. Next, the desired orientation of the FIR is obtained by fitting a line to the distal FAA and its entry point is calculated by intersection with the distal femoral surface. Furthermore, the effect of using a partial leg scan was investigated by clipping the model along its FMDA and comparing the results with the full model. These algorithms are implemented in our in-house software pyFormex. The automated method was tested using CT images of 50 cadaveric femurs, with 0.79 x 0.79 mm pixel size and 0.63 mm slice increment. The Mimics software was used for segmentation and mesh generation. A length of 200 mm was assumed for the FIR.

RESULTS & DISCUSSION

Precise measurements for the FAA and FIR parameters are obtained for a central part of 20 mm and two outer parts of 120 mm, corresponding to 58% of the mean length. The deviations from the full models are less than 2 mm for the FAA, 2.8 mm for the FAA endpoints and 0.7° and 1.3 mm for the FIR orientation and entry point. Removing the central part greatly increases the values, as the curved nature of the diaphysis is not well captured. The automated extraction of the FIR parameters may contribute to a faster and more objective planning of TKA. Further work should be done to extract the mechanical axis to find a patient-specific distal resection angle. Moreover, other rod lengths should be studied, and, as extracting the complete FAA could be redundant, the acceptable scanning reduction for TKA planning in particular should be determined. Finally, a set of manually identified parameters is being obtained to evaluate the computed values.

Figures

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Figure 3 HYPERLINK "http://app.istaonline.org/figures/1627.jpg" \t "_blank"
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Figure 4

Poster: 280
#643

Arthroscopic Biological Resurfacing of the Glenoid in Young and Active Patients With Glenohumeral Osteoarthritis. a Randomized Controlled Trial Comparing to Arthroscopic Debridement.

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Introduction:

Treatment of glenohumeral arthritis in young and active patients is challenging. Although the outcomes of hemiarthroplasty (HA) and Total Shoulder Arthroplasty (TSA) are improving, progressive glenoid erosion and glenoid component loosening have led to a search for joint-preserving arthroscopic alternatives. The purpose of those treatments is to immediately and significantly reduce the shoulder pain, delay the progression of the arthritis and postpone the necessity of a shoulder prosthesis. The current randomized controlled trial (RCT) compares the clinical results and outcome of arthroscopic glenoid resurfacing with a human dermis collagen matrix to arthroscopic debridement.

Patients and Methods:

15 patients with painful, intractable osteoarthritis of the glenoid (Kellgren grade 3-4) were randomized to receive either arthroscopic debridement or arthroscopic resurfacing with a dermal allograft. There were 4 males and 11 females with a mean age of 64. There was no difference between the groups with regard to demographic or preoperative clinical and radiographic parameters. Postoperative clinical evaluation at 3, 6 ,12 and 24 months included Visual Analogue Score (VAS) for pain, Constant, Oxford, UCLA activity and SF12 scores. Patient satisfaction and survivorship of the procedures was assessed. At 1 year an MRI was performed.

Results:

Since arthroscopic debridement was associated with lasting pain and marked dissatisfaction with 5 failures out of 7, further patient recruitment was considered unethical and the RCT was discontinued prematurely. Fifteen patients were included, 7 in the debridement group and 8 in the graft group. At the last evaluation at 2 years, 5 debridement cases had failed due to continuous debilitating pain, of which 3 were converted to a TSA or a HA and 2 were waiting to be re-operated. One resurfacing failed due to loosening of the graft and was converted to a TSA. There was a significant difference between the groups regarding failure (p=0.03 - hazard ratio of 7.3 for debridement). Glenoid resurfacing with a dermal allograft was associated with significant early pain relief and functional improvement (Constant score p=0.028 – Oxford score p=0.018). Clinical evaluation at 2 years revealed a significantly better result in the graft group regarding VAS pain (p=0.001), Constant score (p=0.01), Oxford score (p=0.02) and UCLA score (p=0.0001). The grafts were not visible on MRI.

Discussion:

The current RCT confirms previously reported successful 2-5 years results of glenoid resurfacing with collagen matrices. Despite the small numbers, the outcome of the two arthroscopic treatment methods of glenohumeral osteoarthritis was significantly different. 5 of 7 debridement cases failed versus 1 of 8 resurfacing cases, The graft group presented with a significant clinical improvement both early on and at 2 years. Hyaline cartilage regeneration was demonstrated histologically in a retrieved glenoid graft. Arthroscopic resurfacing with a human allograft can be repeated several times if necessary.

Conclusion:

Arthroscopic glenoid resurfacing with a collagen matrix is a valuable joint-preserving treatment option for glenohumeral osteoarthritis in young and active patients providing significant pain relief and functional improvement.

Poster: 281
#644

Causes of Revision of Hip Resurfacings From a Specialist Independent Centre

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Introduction

Metal-on-metal hip resurfacing arthroplasty (HRA) has been used in increasing numbers to treat hip pathologies in young and active patients. The reasons for HRA revision have evolved with improving surgical experience and techniques. The aim of this study was to investigate the causes of failure and the operative findings in all consecutive HRA revisions performed at an independent specialist centre.

Methods

Since 2001, 113 consecutive HRA revisions were performed in 110 patients. Forty-three primary surgeries were done at our centre, the remaining elsewhere. Eight different HRA designs were revised mainly in females (60%). The mean time to revision was 31 months (0-101). Ion levels were used as diagnostic tool since 2006. Components' orientation was measured from radiographs using EBRA. Harris-Hip-Scores (HHS) were obtained. Histological evaluation was performed at an independent specialist laboratory.

Results

All patients presented with some pain/discomfort. Six HRAs were revised for fracture. The most common pre-operative reason for revision included cup malpositioning (50%), usually excessive abduction or anteversion. The most common intra-operative finding was a bursa (44%) followed by impingement (34%) and metallosis (31%) usually correlated with high metal ions. There were gender-specific differences in component sizes and causes of failure, with a higher incidence of component malpositioning, osteolysis, elevated metal ions, and metal sensitivity in women. High metal ion levels were established with the ASR at a short interval (mean:21 months) and with the BHR at a longer interval (mean: 38 months).

Conclusion

Component malpositioning is the most common cause of HRA failure. Metal ion measurements are an excellent tool to detect wear at an early stage. The revision analysis highlights the importance of surgical experience, indications and prosthesis design.

Poster: 282
#645

Can We Improve Outcome Following Revision of Hip Resurfacings?

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Introduction

Ease of revision was one of the perceived advantages that lead to the increased use of Hip Resurfacing Arthroplasty(HRA). However, studies have shown an increased risk of re-revision following revision of HRA

and poor outcome when adverse soft-tissue-reactions are present. The purpose of this study was to identify factors that improve outcome following revision of a failed HRA, including cases with soft-tissue-reactions.

Methods

113 HRA revisions performed by a single surgeon (2001-10), were retrospectively reviewed. The most common cause of revision was cup-malpositioning(n=57) and the most common intra-operative finding was adverse-soft tissue-reaction/bursa(n=50). Harris-Hip-Score(HHS) was obtained pre-operatively and at latest follow-up (3years, 0.5-10). The initial experience of the first 42 cases (Initial Group) was previously reported (2008). Cases 43-113 comprised the Later Group. Ion levels were used as a diagnostic tool since 2006(n=86). Patients of the Later group were noted to have less soft tissue damage, had significantly bigger THR heads implanted at surgery, were educated of the increased complication risk and wore a brace for 6 weeks.

Results

For the whole cohort, HHS significantly improved post revision (93, 42-100) ($p<0.001$). Ten complications and 6 re-revisions occurred. Outcome {$HHS_{post\text{-}op}$ ($p=0.04$), complication and re-revision rates ($\chi^2=0.005$)} was significantly better in the Later Group compared to the Initial group. The incidence of complications/re-revisions significantly reduced since the introduction of metal ions($\chi^2=0.004$). For the whole cohort, the presence of a bursa did not significantly affect outcome($\chi^2=0.65$). However, patients with bursa in the Later group(n=38) had significant reduced complication($\chi^2=0.005$) and re-revision($\chi^2=0.016$) rates in comparison to those in the Initial Group.

Conclusion

This study highlights the importance of surgical experience, use of ion levels, big THR-heads and patient education/compliance as factors in improving outcome following HRA revision. Patients with soft tissue reactions can have good outcome if operated prior to extensive soft tissue destruction.

Poster: 283
#1031

Two Radius Area Contact- Total Knee Arthroplasty: Short- and Long- Terms Results

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At the end of the eighties, cases of catastrophic poly wear were partially attributed to less congruent total knee designs. This promoted research in more congruent designs and motion-guided kinematics.

The Two Radius Area Contact (TRAC) posterior stabilized prosthesis tried to minimize the bearing and interface stresses to reduce the risk of polyethylene wear and loosening, by maximizing the contact area from full extension to full flexion. This was done by creating two radii of curvature, with some overlap between both during flexion. The post-cam mechanism was also designed to provide further contact surface, and to engage from early flexion on.

85 primary TRAC knee arthroplasties were performed at the Brussels University Hospital (UZ Brussels), by a single surgeon.

The short term results were characterized by 6 cases of AP-luxation's, which could result from design of the prosthesis, (dual track and low jump height). The luxations could all be reduced closed, under anesthesia. A polyethylene exchange was only needed in 1 case. The early engagement of the cam-post mechanism during flexion also increased the load on the extensor mechanism, resulting in 3 cases of patellar component revisions. Another early problem was pain due to synovial tissue impingement between the femoral component and the polyethylene, in the lateral compartment. This was also due to the dual track-design. In 5 patients a synovectomy was performed.

We recently started a medium and long- term review of these cases, in order to see if the theoretical benefits concerning the functional result and the polyethylene wear could be confirmed. In the meantime, of the 85 patients, 43 had died of unrelated causes and 3 were unable to be examined because of extremely poor physical or mental

health. Five patients were lost to follow up. 34 patients could be clinically evaluated after a mean follow-up period of 13 years (range 11-15 years). A radiological follow up with a mean of 10 years (range 10-14 years) could be performed for 47 patients. For the clinical examinations, the WOMAC score, the SF -36 and the Knee Society Score, as well as the visual analogue pain score were used. For the radiological evaluation component position, alignment and radiolucency's were measured using the Knee Society roëntgenographic-scoring-system.

The mean WOMAC score is 20.6% (range 2.3% - 56.2%). The mean score for pain is 6% (range 0% - 22%), stiffness 21% (0% - 62.5%) and for loss of function 27% (range 0% - 97%). The mean Knee Society Score is 86.8% clinical (range 59 – 99%) and 44% functional (range 0% - 90%).The mean range of flexion is 105°. The mean score on the SF-36 questionnaire is 60% (range 22% - 87%). The pain at the time of examination was 6% (range 0% - 30%), the maximal pain 47% (range 0% – 100%) and the minimal pain 6% (0% - 50%). Radiolucent lines are seen in 4 patients, on the femoral as well as on the tibial component. Two revisions are performed, at 4 and 12 years, because of loosening of one or more components of the TKA. Using revision for all causes as the endpoint, the cumulative survival rate at 10 years is 98.68% (95% C.I. 93.28% – 99.79%).

The long- term results are similar to other TKA-designs. The 34 patients, who are clinically evaluated, show limited problems in daily activities. A majority of these patients are satisfied of the functional result after a mean time of 13 years. The radiological evaluation (n = 47 patients) shows well positioned components and little loosening. The short term results show many complications (19%). Except for the synovial tissue impingement between the femoral component and the polyethylene mobile bearing and the luxations, these complications also occur with other TKA designs. Because of these complications, the use of the TRAC-prosthesis was abandoned.

Poster: 284
#914

Pulmonary Findings in Asymptomatic Postoperative Total Joint Arthroplasty Patients

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Introduction:

We have noticed an increase in the diagnosis of pulmonary embolus on post-operative day (POD) #1 and 2. We know that fat emboli are released into the venous circulation during total joint arthroplasty (TJA). We examined asymptomatic patients with multi-detector CT scan to establish the baseline pulmonary findings after TJA.

Methods:

We prospectively scanned 20 patients. Vitals signs (temperature < 38°C, heart rate < 100 beats per minute, RR < 20 breaths per minute, 02 saturation > 92% on room air) and serum creatinine (< 1.1 mg/dL) were normal and closely monitored. All patients were mobilized early, wore thromboembolic stockings and foot pumps, and received 5-mg warfarin loading dose on the night of the procedure. On POD #1, patients underwent multi-detector CT angiogram of the chest with PE protocol. A single radiologist, blinded to the study, evaluated the images.

Results:

Twenty patients met inclusion criteria for participation. There were 15 TKA and 5 THA. There were 8 males and 12 females. The average age was 62 years. Surgeries were done under spinal in 17 patients and general anesthesia in 3 patients. Average tourniquet time for TKA was 53 minutes. Operative time for the THA averaged 68 minutes. All of the CT scans were negative for PE. There were no signs of micro emboli or fat emboli on any scan. No patient went on to develop a PE at 1 year postoperatively.

Discussion/Conclusion:

Despite the fact that emboli are created during TJA, if emboli are seen on a CT scan postoperatively, they should be assumed to be real events with clinical sequelae. If symptoms develop postoperatively, they should not be assumed to be related to "fat embolism." In this prospective baseline study, all patients had entirely negative exams without signs of intra-operative emboli.

Poster: 285
#601

Early Outcome Comparison of MRI Planned Knee Replacement System vs Conventional Anatomic Design

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Early Outcome Comparison of MRI Planned Knee Replacement System vs Conventional Anatomic Design

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Introduction:

The Signature system has been hailed as a new way to perform arthroplasty of the knee. It combines the accuracy in restoring mechanical axes of navigation with the convenience and familiarity of classical surgical techniques. With this comes the expectation that they should produce better functional results. In the literature, thus far, there is little data to corroborate this. The aim of this paper is to compare the early functional outcomes of this with the cemented AGC knee replacement system.

Methods:

Since April 2010, 25 patients underwent Signature knee replacements during this period for symptomatic degenerative or inflammatory arthritis with varying levels of deformity. Oxford functional scores were taken pre-operatively, at 6 weeks, 3 months and 6 months. These were then matched to an equal number of patients that had undergone an AGC knee replacement by the same surgeon. They were matched by pre-operative functional Oxford scores, age and gender.

Results:

The mean age for our patients was 63.4 years at the time of surgery. The mean follow-up period was 6.9 months. There have been no revision procedures required or complications in either group so far. The mean pre-operative Oxford score was 44.4, 26.3, 25 and 19 pre-operatively, at 6 weeks, 3 months and 6 months respectively for the Signature knee group. The AGC group has had comparable results thus far at scores 43.2, 28.4, 20.1 and 19.7 respectively. There is no statistical significance in the early post operative scores between the two groups. More results are to follow.

Conclusions:

To our knowledge this is one of the earliest reports of functional results following the new technique of knee mechanical axis restoration for arthroplasty surgery. The system showed comparable results at similar post-operative time periods with the conventionally performed AGC knee replacement system.

Poster: 286
#889

Efficacy of UHMWPE Dyneema Purity(R) Fiber in Fusionless Posterior Spinal Instrumentation in an Ovine Model

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INTRODUCTION

Surgical correction of spinal deformities in growing children can be performed with or without spinal fusion. Sublaminar wiring may preserve growth of the non-fused spine after correction of the deformity. Neurological complications and wire breakage are the main clinical problems during the sublaminar passage and removal of

currently used metal wires. In this pilot study a posterior hybrid construction using medical-grade UHMWPE (Dyneema Purity® fiber) wires was assessed in an ovine model. We hypothesized that such a hybrid construction with UHMWPE wires can safely replace the current method in which titanium sublaminar wires are used, while providing sufficient stability of the non-fused spine with preservation of growth.

MATERIALS AND METHODS

This study included 6 Tesselaar sheep, age 7±2 months. Two pedicle screws were placed at lumbar level (L4). Two titanium rods (diameter 4.5 mm) were attached to the screws and four consecutive laminae (T12, T13, L1, L2) were fixated to the rods using 3 mm wide UHMWPE constructions (Dyneema Purity® fiber) on the left side and 5 mm wide constructions on the right side [Fig 1; Fig 2]. The wires were fixed to the rods with a customized double loop sliding knot and tightened with a tensioning device. As a control, titanium sublaminar wires (Atlas cable, Medtronic) were applied in one animal. The animals were sacrificed after a (minimal) postoperative period of 15 weeks. Post mortem the spines of the animals were harvested. Radiographs and CT-scans were made. The vertebrae were separated by dissection and fixated in formaldehyde for macroscopic and histological evaluation.

RESULTS

One animal developed a wire fistula and one animal died one day postoperatively due to anesthetic complications. None of the 3 or 5 mm knots loosened and no neurological complications occurred. An average of 9 mm growth was seen over the operated segment. Computed tomography confirmed the preserved stability. Even though no decortication was performed, several bone bridges, causing fused levels, were seen on CT-scans. Macroscopical analysis by cryogenic sections showed no inflammation at lamina and dura levels containing Dyneema Purity® fiber, with the exception of the animal with the fistula, where it was only observed at one 5 mm knot. Histological sections showed minor bone growth in between the UHMWPE wires, confirming the biocompatibility of the material [Fig 3]. No signs of inflammatory reactions were observed and no significant differences in bone reaction between Dyneema Purity® fiber and titanium were found.

DISCUSSION

This pilot animal study shows that the UHMWPE sublaminar wire made with Dyneema Purity® fiber has good handling and tensioning properties and can provide sufficient stability in fusionless spinal instrumentation while allowing growth. The examined model proves to be a feasible spinal model, without occurrence of neurological problems. Heterotopic ossification due to periostal reactions caused some restrictions for this model. Preventing this in future experiments will optimize the ovine model. Future studies will test instrumentation with UHMWPE sublaminar wires in an animal scoliosis induction model.

Figures

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HYPERLINK "http://app.istaonline.org/figures/1633.jpg" Figure 1

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Poster: 287
#958

Kinematic Comparison of Robot-Installed Uni Knees and Patella Resurfacing With Standard Total Knees Using a Crouching Machine

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INTRODUCTION

Due to the advantages of reduced hospitalization, early recovery and improved function, Unicompartmental Knee Replacement (UKA) is increasing in application. However, follow-up studies report certain problems, namely progress of arthritis in other compartments, instability, and tibial loosening. These factors can be addressed by accurate component placement based on bony anatomy and soft tissue balancing, and with options for compartmental resurfacing. The RIO haptic robotic arm system and the RESTORIS Multicompartmental Knee System (MAKO Surgical Corp) was designed to those objectives. In our study we tested the hypotheses that the kinematics after compartmental replacement would be the same as in the normal intact knee, and that the patella would track smoothly across the patella flange and femoral uni component.

METHODS & MATERIALS

Each of 7 knee specimen was mounted in an up-and-down crouching machine where the quadriceps length and flexion-extension was controlled by a motor and where hamstrings forces were applied. Motion data was captured using an optical system following targets fixed in the femur, tibia and patella. After testing the intact knee, the RESTORIS tibial component, femoral component, patella flange, and patella resurfacing were implanted using the RIO. Motion data was again captured. Two more tests were run with a typical PCL retaining design (CR) and a posterior stabilized design (PS). After testing, the remaining bone surfaces and target points were digitized. Using Rapidform software, the bones and components were positioned in 3-D space. The positions of the centers of the lateral and medial femoral condyles, based on the circular axis, were projected on to the tibial surface, at 15 degree flexion increments. The contact areas of the patella on the femur and its components were displayed.

RESULTS

The lateral and medial position curves were compared with the intact knee, by determining the magnitudes of the differences in positions at each flexion angle; the ideal implant would have zero differences throughout. On the lateral side, the differences were significantly smaller for the UKA compared with the CR and PS in mid-flexion, but there were no significant differences in early and late flexion. Overall, all implants showed posterior displacement with flexion as in the intact knee. On the medial side however, the differences between the UKA and intact were less than 3mm throughout flexion, reproducing a highly stable medial side in the AP direction. The CR and PS however showed differences in position up to 7mm up to 75 degrees flexion and up to 11mm in higher flexion. The contact analysis of the patella on the femur showed a transition from the patella flange to inclusion of the inner-anterior aspect of the femoral implant, as in the normal intact knee. The acceleration data indicated smooth continuous acceleration profiles for both the intact and UKA, with no discontinuities for the UKA which might have indicated a ‘bump’ in the transitions of the patella.

DISCUSSION

Our study showed that, especially on the medial side, normal kinematics was restored after a uni/patella replacement, and that the patella tracked smoothly across the components. These findings support the hypothesis of the study.

ACKNOWLEDGEMENTS

Daniel Hennessy for construction of the test machine, MAKO for partial funding.

Poster: 288
#633

Cadaveric Evaluation of the MAKO Multi Compartmental Knee Kinematics

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INTRODUCTION:

The MAKO Surgical Rio Robotic Arm utilizes the pre-op CT images to plan positioning of the uni-condylar and patella-femoral components in order to achieve the most desirable kinematics for the knee joint, while preserving the cruciate ligaments. We hypothesize that the anatomic matching surfaces and the cruciate retaining design of the Restoris knee will best replicate normal knee kinematics. It is important to preserve the tracking of the patella for normal knee motion and the preservation of the natural moment arms for mechanical advantage (Li, 2010).

We will test the healthy cadaveric knee versus the MAKO knee and the most common TKR designs; Posterior Stabilizing (PS) and Cruiciate Retaining (CR) TKRs in order to evaluate and compare the kinematic properties.

METHODS:

Seven healthy male left knees were dissected to leave only the knee capsule, and the quadriceps tendon intact. The femur and the tibia were cut 20cm from the joint line and potted with cement into a metal housing. The knee was attached to a crouching machine (Figure 1) capable of moving the knee joint though its normal kinematics from extension to maximum flexion, validated in previous studies (Yildirim, 2009).

Forces applied to the quadriceps tendon allowed the knee to flex and extend physiologically, and springs attached to the posterior were substituted as the hamstrings at a rate of half the force exerted by the quadriceps as shown in the literature. An accelerometer attached to the patella tracked the accelerations in 6dof to assess the conformity of the patellar button on the femoral components. Three dimensional targets attached to the bones were tracked by a computer software (RapidForm, Inus Technology, Seoul, Korea). A cruciate retaining and posterior stabilized TKR design were chosen to represent the TKRs most commonly available in the market. The intact, MAKO implanted, CR and PS TKR knee designs were tested in sequence on the same specimens. The computer software plotted the contact locations which could then be quantitatively compared for each given scenario (Figure 2).

RESULTS:

Our results showed that the MAKO knee kinematics resembled the normal knee kinematics throughout the knee flexion range. An average of 15 degrees of internal tibial rotation was observed for both the intact and MAKO knees. The TKR designs did not show internal rotation with the increasing flexion angle, while the femoral roll back in high flexion was only replicated by the post of the PS design and not by the CR design.

Accelerometer data collected from the patella showed that the normal and MAKO accelerations matched indicating the smooth transition between the PF and TF components (Figure 3). Both the PS and the CR designs showed accelerations.

DISCUSSION:

Anatomic restoration of the joint surfaces and retention of the cruciate ligaments maintained normal kinematics. Pre-op planning help create a smooth transition between the PF and TF components as indicated by the lack on acceleration readings as the knee extends and flexes. PS and CR designs cause increased accelerations presumably due to the paradoxical motion discussed previously (Yildirim, 2009).

Figures

Poster: 289
#855

The Effects of Low-Intensity Pulsed Ultrasound on Tendon-Bone Healing in a Transosseous Equivalent Sheep Rotator Cuff Model

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Introduction:

Animal studies examining tendon-bone healing have demonstrated that the overall structure, composition, and organization of direct type entheses are not regenerated following repair. We examined the effect of Low-Intensity Pulsed Ultrasound (LIPUS) on tendon-bone healing. LIPUS may accelerate and augment the tendon-bone healing process through alteration of critical molecular expressions.

Methods:

Eight skeletally mature wethers, randomly allocated to either control group (n=4) or LIPUS group (n=4), underwent a clinically relevant, transosseous-equivalent rotator cuff repair, following injury to the infraspinatus tendon. All animals were sacrificed 28 days post surgery to allow examination of early effects of LIPUS. Humeral head – infraspinatus tendon constructs were harvested and processed for histology, immunohistochemistry, and microcomputed tomography (micro-CT). Histology was qualitatively graded for new bone formation, cellular activity, Sharpey's fibres and collagen fibre allignment. Immunohistochemistry staining for protein expression of BMP-2, Smad4, VEGF, RUNX2 and appropriate controls was performed. Protein expression was graded according to both staining intensity and cellular distribution. Micro-CT Scans were examined for Bone Mineral Density (BMD) using MIMICS software (Mimics 12.0, Materialize, Belgium).

Results:

The surgery and LIPUS treatment were well tolerated by all animals. Placement of LIPUS sensor did not unsettle the animals. Histologic appearance at the tendon-bone interface in LIPUS treated group demonstrated general improvement in appearance compared to controls. Generally a thicker region of newly formed woven bone with increased osteoblast activity along the bone surface was evident in the LIPUS group. A continuum between the tendon and bone, in an interdigitated fashion, containing Sharpy's fibres, was also noted (Figure 1: control A, B; LIPUS D, E). Immunohistochemistry revealed an increase in the protein expression patterns of VEGF ($p = 0.038$), RUNX2 ($p = 0.02$) and Smad4 ($p = 0.05$). There was no statistical difference found in the expression patterns of BMP2. (Figure 2). Bone mineral density measurements at the tendon-bone interface showed an increase in the LIPUS treated group ($P<0.01$) (Figure 3).

Discussion:

Ovine Transosseous-Equivalent Rotator Cuff Repair Model

Results from our study suggest that the double row suture bridge construct provides adequate initial repair strength required to withstand mechanical forces present postoperatively. This model should be considered when studying treatment therapies aiming to improve tendon-bone healing in an extra-articular environment such as the rotator cuff repair.

LIPUS Treatment and Tendon-Bone Healing

Our results noted a positive biological effect on tendon-bone healing following a 4 week treatment with LIPUS. Immunohistochemical staining data suggests that the BMP-2 and VEGF mediated pathways share a major target gene (RUNX2) and together, are essential in the healing process of tendon to bone.

Conclusion:

The results of this study indicate that LIPUS may aid in tendon to bone healing process in patients who have undergone rotator cuff repair. This treatment may also be beneficial following other types of reconstructive surgeries involving the tendon-bone interface.

Figures

Poster: 290
#451

Uni-Compartmental Knee Arthroplasty (UKA)

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Purpose:

Assessment of functional outcome of uni-compartmental knee arthroplasty (UKA) for medical compartment osteoarthritis of the knee.

Patients and Methods:

Fifty-three UKAs were performed in 51 patients between 2004 and 2009. The indications included medical compartment osteoarthritis, osteonecrosis of the knee with correctable varus deformity of less than 15 degrees. There were 38 males and 13 females. Two patients had bilateral knee surgery. The average age was 67 years (range 57 to 74 years). The average BMI was 27 (range 23 to 33). The average follow-up was 24.2 months (10 to 60 months) Only one type of prosthesis (Zimmer) was used. The evaluations included functional score and IKDC score and radiographs of the knee.

Results:

The functional score of the knee was 60.6 before and 90.2 after surgery ($P < 0.001$). The IKDC score was 30 before and 87 after surgery ($P< 0.001$). According to IKDC rating, the knee was rated normal in 51%, nearly normal in 38%, abnormal in 8% and severely abnormal in 3%. On radiographs, radiolucency between the tibia component and subchondral bone was noted in only one case. Complications included cement protrusion in one, and pain of unknown origin in 2.

Discussion:

The advantages of UKA include rare complications such as infection, DVT and stiffness after TKA, and higher patient satisfaction after revision for failed UKA than revision for failed TKA. The disadvantages include the cumulative revision rate for UKA is approximately 22% in patients under 60 years of age. Overall, UKA has 85% to 98% survival in 10 to 20 year follow-up.

Conclusion:

UKA is an excellent option particularly for middle-aged patients. UKA relieves pain and restores knee function close to normal kinematic and gait pattern. Proper patient selection and precise surgical skill are the keys to success in UKA.

Poster: 291
#452

Long-Term Outcomes of Shockwave Therapy Osteonecrosis of the Femoral Head With 8 to 9 Years Follow-Up

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Purpose:

This study analyzed the long-term outcomes of extracorporeal shockwave therapy (ESWT) and core decompression for early osteonecrosis of the femoral head (ONFH) with 8 to 9 years follow-up.

Methods:

The cohort consisted of 23 patients (29 hips) in ESWT group and 25 patients (28 hips) in surgical group. Patients in ESWT group received 6000 impulses of shockwave therapy at 28 kV (equivalent to 0.62 mJ/mm^2 energy flux density) to the affected hip. Patients in surgical group underwent core decompression and non-vascularized fibular graft. The evaluations included clinical assessment, X-ray and MRI. Clinical assessments included pain score and Harris hip score for activities of daily living and work capacity. The average follow-up was 103.5 ±3.4 months (93 to 106 months) and 104.5±4.3 months (95 to 108 months) for ESWT and surgical group respectively. The primary end-point was the number of total hip arthroplasty performed during the course of treatment. The secondary end-point was the improvement in hip pain and function. The tertiary end-point was the change in x-ray

and image studies.

Results:

The overall clinical outcomes showed good or fair in 76% and 21%, and poor in 24% and 79% for ESWT and surgical group respectively. THA was performed in 3% and 21% at one year, 10% and 32% at 2 years and 24% and 64% at 8 to 9 years for ESWT and surgical group respectively. The differences in pain and Harris hip scores were significant at different time intervals favoring the ESWT group. There was a trend of decrease in the size of the lesion after ESWT as compared to the surgical group.

Conclusion:

ESWT appears more effective than core decompression and bone grafting for early ONFH with 8 to 9 years long-term follow-up.

Poster: 292
#431

Stem First Technique in Cementless Total Hip Arthroplasty

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Introduction:

Dislocation following total hip arthroplasty (THA) is one of the most common complications with 1 to 5% incidence. Previous studies suggested causes for dislocation as: 1) Mismatching of cup positioning and stem anteversion, 2) Impingement between cup and neck of stem prosthesis. Most often positioning of the stem is anatomically predetermined, while the orientation of the cup is more flexible. Since February 2010, we have applied *stem first method* and *cup first method* amongst primary THA cases. The purpose of this study is to compare cup positioning and neck anteversion between *stem first* group (Group S) and *cup first* groups (Group C).

Methods:

From February 2010 to April 2011, 38 primary THA cases were applied to this study. Subjects were assigned to either the Group S or the Group C in order of the date of operation. With *stem first* method, we did canal preparation and stem trial first, then determined cup orientation according to the stem direction and impingement. In all cases, we planned to insert prostheses with approximately 50 degrees combined anteversion (=cup anteversion + stem antetorsion). Postoperatively, we measured cup anteversion and stem antetorsion using CAT scan through all cases to evaluate combined anteversion. We compared mean differences using the *t* test. A *P* value of less than 0.05 was considered statistically significant.

Results:

There were 16 females and three males in Group S, 15 females and 4males in Group C (p=0.66). Average age was 58.8 years in Group S and 62.1 years in Group C (p=0.34). In Group S, fifteen hips were replaced for osteoarthritis, four for avascular necrosis, and one for rheumatoid arthritis. In Group C, fifteen hips were replaced for osteoarthritis, three for avascular necrosis, two for rheumatoid arthritis (p=0.83). Average BMI was 23.8 in Group S and 22.9 in Group C (p=0.46). Average preoperative femoral neck anteversion using CAT scan were 28.0 degrees in Group S and 26.7 degrees in Group C (p=0.76). Before operation, average Japanese Orthopedic Association score was 32.2 in Group S and 37.6 in Group C (p=0.18). There was no significant difference in characteristics of patients between two groups. Average intraoperative hemorrhage was 657.4ml in Group S and 627.3ml in Group C (p=0.78). Average operation time was 115 minutes in both groups (p=0.99). Average cup anteversion was 14.9 degrees in Group S and 26.7 degrees in Group S ($p<0.05$). Average stem antetorsion was

30.7 degrees in Group S and 24.5 degrees in Group C (p=0.23). Average combined anteversion was 43.3 degrees in Group S and 49.9 degrees in Group C (p=0.32). Average cup inclination was 40.6 degrees in Group S and 41.8 degrees in Group C (p=0.64).

Conclusion:

In this study, we could find no significant difference between two methods in intraoperative hemorrhage, operation time, stem antetorsion and combined anteversion. Besides cup anteversion was the only one factor which was significantly different between two groups.

Poster: 293
#571

Cadaveric Comparison of Two Types of Saw Blades Used in Total Knee Arthroplasty.

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Introduction

Alignment during total knee arthroplasty can be achieved through various methods including conventional instrumentation and computer assisted navigation. Alignment is partially dependent on the accuracy of the proposed tibial and femoral osteotomies. The purpose of this study is to compare the abilities of a conventional saw blade to an oscillating tip saw blade (Stryker Precision™) designed to minimize soft tissue damage, with specific regard to accuracy using computer navigation to measure alignment.

Methods

Standard femoral and tibial trackers were placed on four cadaveric knees (frozen and thawed) using Stryker EndTrac™ computer navigation, and the limbs were registered in the usual fashion. Using both a conventional saw blade and the Stryker Precision™ oscillating tip saw blade, sequential femoral and tibial osteotomies were performed on each paired cadaveric knees in 4 mm increments to reproduce similar osteotomies. A total of 8 femoral and 8 tibial cuts were made with each saw blade (32 cuts total). Pre- and post-osteotomy alignment was measured with computer navigation. All cuts and measurements were made by the two senior-most authors (LP, RS). Saw blade excursion was evaluated during each cut using methylene blue dye.

Results

The mean femoral coronal angulation of the conventional blade was 0.38° valgus versus 0.19° valgus in the oscillating tip blade. The mean tibial coronal angulation of the conventional blade was 0.31° varus versus 0.06° valgus with the oscillating tip blade. In the sagittal plane, the mean femoral alignment was 2.07° of hyperextension with the conventional blade and 1.63° of hyperextension with the oscillating tip blade. The mean tibial sagittal alignment with the conventional blade was 1.19° hyperextension versus 0.81° of hyperextension with the oscillating tip blade. A Wilcoxon-Mann-Whitney test (a non-parametric analog to the independent samples t-test) demonstrated no statistically significant difference between the two blades in terms of accuracy (t=0.17, p=0.35) with all femoral and tibial cuts combined. Although no statistical difference was shown, the measurements of the distally pivoting blade did trend toward slightly more accurate cuts with less hyperextension. Additionally, blade excursion was less with the distally pivoting saw blade confirmed with methylene blue dye.

Discussion

The two saw blades demonstrated equal accuracy in both planes with coronal cuts within 0.5° degrees of neutral and sagittal cuts consistently angulated in about 1-2° hyperextension. In conclusion, the two saw blades were no different with regard to accuracy. The use of the oscillating tip blade was confirmed to show less excursion, which may be beneficial in the clinical setting with less damage to surrounding soft tissue structures.

Poster: 294
#912

The Effect of Different Processing Conditions on the Wear Performance of UHMWPE and a Rationalisation via Reptation Modelling

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The Effect of Different Processing Conditions on the Wear Performance of UHMWPE and a Rationalisation via Reptation Modelling

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Introduction:

Orthopaedic grade ultra-high molecular weight polyethylene (UHMWPE) has been for over 40 years the only widely used bearing material for articulation with metallic components in total knee arthroplasty (TKA). However, polyethylene-related total knee failures especially Type 2 fusion defects have limited the lifetime of these joints [1-4]. The present study aims to reduce the probability of material failure by examining the hypothesis that there is a correlation between material failure of UHMWPE components and the precise temperature-time (T-t) history employed during fabrication. The T-t history employed during manufacture strongly influences the extent of reptation and hence the extent of interparticle cohesion [2]. From the T-t history one is able to infer the upper bound of MW of those molecular chains which have fully reptated across grain boundaries; this is the maximum reptated molecular weight (MRMW).

Materials and Methods:

Wear tests on UHMWPE plates (manufactured by direct compression moulding in the same way as ArCom UHMWPE) were carried out using a Durham four-station multi-directional pin-on-plate wear screening tester. This simultaneously generates both reciprocating and rotating motions. The plates were formed at a variety of processing temperatures from 145°C to 175°C and with dwell times of either 15 or 30 minutes, giving different degrees of inter-particle diffusion. The material combination of flat-ended metallic indentors articulating against UHMWPE plates was constructed to mimic conformal contact conditions in knee prostheses.

Wear tests (complying with ISO 14243-2: 2000 for cleaning and measurements) were conducted up to three million cycles (MC). New born bovine calf serum was used as the lubricant diluted to a protein content of 17g/l. The load applied in the present study was 40N giving a pressure of 2.0MPa. The frequencies were pre-set at 1Hz for both reciprocation and rotation. The stroke length was 20mm. The machine was stopped every 0.25MC to clean the samples and record masses gravimetrically. With a soak control, the mass losses of worn plates were corrected for fluid absorption. ABAQUS/Standard v6.8 was used to simulate the moulding process of the 3mm thick UHMWPE plates as used in the wear study. Various processing temperatures, 145ºC to 205ºC, and dwell times, 15 to 60 minutes, were investigated. Structural analyses were made using a non-contact profilometer.

Results and Discussion:

Low wear was found for UHMWPE moulded at the high temperature with wear rate of $0.93\times10^{-4}\pm0.11\times10^{-4}$mg/m. This corresponds to MRMW of 2.19×10^{6}g/mol for the temperature of 175°C. For 175°C, the doubling of dwell time to 30 minutes results in a 18.5% decrease in wear rate. The ascending trend of MRMW of UHMWPE with temperatures indicates high inter-particle cohesion at high temperatures. Experimental wear rate decreases significantly with increasing MRMW and an approximate relationship is: wear rate (in 10^{-4}mg/m) =2.4 – 0.67×MRMW where MRMW is in 10^{6}g/mol. This was found experimentally for the molecular weight range 1.7 to 2.6×10^{6}g/mol. For the temperature of 145°C, some defects due to incomplete consolidation were observed in the surfaces initially and after the 3MC wear test micro-cracks were observed in one of plates. Environmental Scanning Electron Microscopy (ESEM) images showed that material ruptures occur along the interfaces.

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Poster: 295
#421

Investigation of Anterior Cruciate Ligament Deficiency in Total Knee Arthroplasty

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Introduction

Anterior cruciate ligament (ACL) deficiency is commonly identified at the time of total knee arthroplasties (TKAs) even without prior history of ligament injury or instability. A previous study reported that the ACL deficiency may be due to the femoral intercondylar notch narrowing with the osteoarthritic progress, which can lead to attrition and rupture of the ACL. However, the relationship between ACL deficiency with clinical or radiographic data was not yet reported. Therefore, the purpose of this study is to investigate the ACL deficiency using clinical and radiographic data and to compare them with non-ACL deficient knees.

Patients and Methods

Consecutive primary TKAs were performed in 120 knees at 83 patients in our institution over one year period. Only primary osteoarthritis (OA) was included in this study, patients with inflammatory arthritis or prior intraarticular trauma were excluded. There were 14 men and 69 women with an average age of 72 years (range, 49-88). The clinical data of each patient including age, body mass index (BMI), range of motion, functional scores based on Japan Orthopaedic Association (JOA) scoring system, whereas the radiographic data like femoral tibial angle (FTA), Kellgren-Lawrence classification for OA, and intercondylar width using computed tomography (CT) were recorded. The ACL was inspected at the time of surgery. The absent of ACL was considered as ACL deficiency whereas ACL intact was considered as an internal control.

Results

There were 57 knees found as ACL deficiency, whereas 63 ACLs were found intact at the time of surgery. There was no significant difference with respect to age, BMI, JOA scores, range of motion and FTA, whereas a statistical difference in Kellgren-Lawrence classification and the width of intercondylar notch was noted between ACL deficient and non-ACL deficient groups. In particularly, a significant decreased intercondylar width with 3.4±3.3 mm was noted in ACL deficient knees in comparison with an average of 10.4±2.8 mm in non-ACL deficient knees. A high rate (47%) of full or half bony bridge formation across the intercondylar was observed by CT scanning in ACL deficient knees.

Discussion

Our data showed that ACL deficiency was strongly associated with intercondylar notch narrowing and coupled with existing joint arthrosis progress, indicating the ACL deficiency in the OA knee can occur as a result of crossing notch osteophytes, which may lead to impingement and ligament attrition. Interestingly, we did not find any significant difference with respect to joint alignment evaluated by FTA between two groups, suggesting the severity of varus or valgus deformity does not affect the ACL integrity too much. The further study is needed to investigate the posterior cruciate ligament (PCL) function, since the absence of ACL may lead to alterations in knee kinematics and promote the degeneration of PCL, which influences the choice of PCL-retaining or –sacrificing TKAs for patients.

Poster: 296
#420

The Effect of Medial Collateral Ligament Release on Gap Balance in Total Knee Arthroplasty

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Introduction

A well-balanced soft tissue is essential for a good result when performing total knee arthroplasty (TKA). Imbalance of collateral ligaments and incorrect mechanical alignment in varus knees, which is very common in osteoarthritis patients, can be corrected by soft tissue release such as the medial collateral ligament (MCL) release. However, the correction of varus in extension and flexion after MCL release was not yet quantitatively analyzed, we therefore decided to investigate the effect in a clinical study.

Patients and Methods

182 varus knees in 155 patients with an average of 75 years were included in this study. Among them, PCL-retaining (CR) TKAs were performed for 127 knees, whereas PCL-sacrificing (PS) TKAs were performed for 55 knees. All surgeries were performed by one surgeon (RK). The superficial MCL release was performed only when a medially tight gap was achieved in both flexion and extension of knee. The effects of release on gap balance in flexion and extension were measured by a knee balance tensor (Stryker, USA).

Results

A significant varus deformity in extension than in flexion was observed before the MCL release. The MCL releases were performed in 44 of CR knees and 18 of PS knees. For CR knees, the average angle of varus was decreased from 6.0±2.7° prerelease to 3.0±2.7° postrelease in extension, whereas a result of 5.0±3.6° of varus prerelease was changed to 0.2±3.2° postrelease in flexion, respectively. On the other hand, for PS knees, the average angle of varus was decreased from 6.0±2.9° prerelease to 3.6±2.5° postrelease in extension, whereas the varus angle of 4.7±2.7° was changed to 0.6±3.6° of valgus in flexion after the release. Irrespective of CR or PS knees, MCL release significantly corrected the varus deformity in flexion than in extension. Interestingly, a tendency toward valgus deformity only in flexion was noted in some CR and PS knees after the MCL release.

Discussion

During TKAs, achieving anatomic limb alignment and proper soft tissue balance are very important for preventing a destructive load on the joint and to create a stable joint over the full range of motion. Our results demonstrated that the release of superficial MCL is an effect way to correct the medially tight deformity, especially the varus in flexion is corrected significantly in comparison with extension. However, possibility of valgus deformity associated with overrelease should be taken into consideration to avoid a newborn imbalanced knee.

Poster: 297
#651

CAS vs. Manual TKA: No Difference in Clinical or Radiographic Outcomes at 5-Year Follow-Up

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Introduction:

The use of computer-assisted surgery (CAS) offers the experienced surgeon the ability to improve limb and implant alignment and reduce outliers. The initial interest in navigation was due not only to potential improvements in alignment, but in improved accuracy at each step that may improve femoral rotation, component sizing, and tibial slope. A previous case-controlled study by this author demonstrated no significant difference in clinical, functional, or radiographic outcomes between CAS and manual TKA at short term follow-up. We attributed these results to the improvements in the performance of manual TKA that had been realized through the learning effects afforded by working extensively with an intraoperative navigation system. The purpose of the present study was to determine whether any differences in clinical, functional, or radiographic outcomes could be

elicited between patients who underwent either CAS or manual TKA at 5 year follow-up.

Methods:

Seventy-eight consecutive total knee arthroplasties were performed by a single surgeon with extensive prior experience in both CAS and manual TKA between. Of the seventy-eight arthroplasties, forty were performed with manual instruments and thirty-eight with CAS. CAS was performed using an image-free intraoperative navigation system. The groups were identical with regard to age, sex, body mass index, diagnosis, surgical technique, implants, and peri-operative management. Pre-operative and post-operative clinical examinations were recorded and compared at four weeks and 5 years postoperatively. 61 patients were available for 5-year follow-up. Pre and post-operative radiographic measurements of the mechanical axis were evaluated by an observer blinded to the surgical technique. The Knee Society scoring system was used to assess clinical and functional outcomes. The UCLA activity score was used to assess the patient's overall frequency and intensity level of physical activity.

Results:

Clinical and functional results were similar between manual and CAS TKA at 5-years postoperative (Figure 1). There was no statistically significant difference between the magnitude of improvement between preoperative and 5-year postoperative knee or function scores. There was no statistically significant difference between 5-year postoperative pain scores, ROM, or UCLA activity scores (Figure 1). Mechanical axis as measured on plain radiographs did not reveal a significant difference between manual and CAS at 1 month or 5-year postoperative. Preoperative and 1 month postoperative ROM demonstrated a statistically significant correlation with 5-year postoperative ROM. 5 year postoperative function score and the magnitude of improvement in function was correlated with 5-year postoperative UCLA activity score.

Discussion:

This study found similar clinical, functional and radiographic outcomes at 5-year follow-up between manual and CAS patients who underwent TKA. These results were consistent with the short-term results found previously in the same patient cohort. We continue to believe that the learning effects afforded by working with a navigation system can lead to improvements in manual TKA technique, contributing to improved manual accuracy with regard to femoral component rotation and positioning, tibial slope, component size selection, and mechanical axis.

Poster: 298
#653

A Comparison of the Accuracy of Customized Instrumentation in TKA Between Arthroplasty and General Orthopaedic Surgeons

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Introduction:

Computer-assisted surgery (CAS) was developed to improve limb and implant alignment in TKA. It has not been found helpful to the general orthopaedic surgeon. Customized instrumentation (CI) utilizes preoperative MRI reconstructions to create custom cutting guides and may offer the general orthopaedic surgeon a more accurate and reproducible TKA. The purpose of this study was to evaluate the accuracy with which Joint arthroplasty surgeons at a large academic institution and a General orthopaedic surgeon in a community hospital could perform TKA using CI.

Methods:

111 CI TKA were performed by two joint arthroplasty-trained surgeons at a large academic institution and 98 CI TKA were performed by a general orthopaedic surgeon in a community hospital. CI-predicted femoral and tibial

component size from the CI template was compared to the actual component selection. CI-predicted resection levels for the femur and tibia were recorded and compared to the actual resections using manual calipers. The frequency and magnitude of additional bone resections were recorded. Postoperative radiographic alignment was evaluated.

Results:

The CI system accurately predicted femoral component size in 89% of cases for the arthroplasty-trained and 93% for the general orthopaedic surgeon. Results were similar in regards to the discrepancy between CI predicted and actual femoral and tibial bone cuts. The frequency of additional bone resections beyond the CI predicted resections was similar. Postoperative radiographic alignment was similar between the two groups.

Discussion:

Customized instrumentation is capable of accurate TKA for both the arthroplasty-trained and general orthopaedist. The adaptability of the system to familiar instruments, ease of placement of the customized cutting guides, ability to perform the anatomic registration preoperatively in three-dimensions, and reduced instrumentation requirements are notable benefits of CI. Customized instrumentation is capable of accurate TKA and may offer an attractive alternative to CAS for the performance of a more accurate TKA, especially for the general orthopaedic surgeon.

Poster: 299
#799

Rotator Cuff Reconstuction and Humearl Head Replacement for Rotator Cuff Defecint Arthropathy Can Improve Shoulder Range of Motion in Patients With Pseudoparalysis

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(Purpose)

Recently, reverse shoulder arthroplasty in patients with rotator cuff deficient arthropathy (RCDA) is widely performed in the world. However, it is not able to use in Japan yet. We performed a novel strategy for RCDA from 2001. The smallest size of humeral head was used for closing the cuff defect. If the cuff defect was not able to cover by decreasing the head size, we add muscle tendon transfer such as latissimus dorsi transfer for posterosuperior defect and pectoralis major transfer to cover anterosuperior defect. The aim of this study was to investigate shoulder range of motion (ROM) aftrer this strategy for RCDA with pseudoparalysis of the shoulder.

(Materials and Methods)

23 shoulders in 22 patients were studied. The mean age at the time of surgery was 73(range 58 to 83 years). Rotator cuff defect was covered without tendon transfers in 16, with tendon transfers in 7(6 latissimusdorsi and 1 pectoralis major). We investigated a postoperative ROM of the shoulder and the shoulder scores of Japanese Orthopaedic Association (JOA). Follow-up ranged from 1 year to 9 years and averaged 2.3 years.

(Results)

All but 3 shoulders could able to elevate more than 100 degrees but three. Averaged postoperative flexion was improved from preoperative 40 to postoperative 129. Averaged postoperative external rotation of the shoulder improved from preoperative 9 to postoperative 31 degrees. The JOA score improved from 33.2 points to 77.2 points.

(Conclusion)

We could expect good functional recovery in patients showing pseudoparalysis by RCDA with the rotator cuff repair and reconstraction using the smallest humeral head replacement.

Poster: 300
#754

Uncemented Tha for Rapidly Destructive Coxarthropathy

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Rapidly destructive coxarthropathy (RDC) is a clinical disease concept propounded by Poster in 1970 and has an unknown etiology characterized by a rapid destruction of the acetabular and femoral aspects of the hip joint. In RDC, the joint destruction progresses in six to twelve months. This lesion is relatively rare to found.

Material and Method

At present we have treated 45 joints of RDC in 44 patients by uncemented THA. Among them, we evaluated 29 hips in 28 patients (two males and 26 females) with one or more years follow-up. The average age at the surgery was 74 (56 to 84). The average follow-up period was 2.2 (1 to 9.1) years. The patients were evaluated clinically and radiologically.

Result

The Harris Hip Score was 31 (2 to 61) before the surgery and improved to 89 (67 to 100) at the final follow-up. We had no severe systematic and local complications. All implants were stable at the final follow-up. In the non-affected side hip, Singh's classification was Grade IV in all patients, the average bone mineral density ratio against YAM (young adult mean) in DXA was 89.9 (54 to 132) %, and the average pelvic angle (indicates the posterior tilt of the pelvis) was -36.9 (-10 to -67) degrees.

Discussion

Some etiologic agents have been pointed out for RDC, such as osteoporosis or microtrauma or pelvic malalignment. In our study, the pelvic malaglignment seemed to have some effect while osteoporisis few one. The outcome of our uncemented THA was satisfactory while some authors had recommended cemented THA. Three out of twenty patients lacked of pain in the hip joint. RDC is a lesion that can be added to the differential diagnosis when a patient has rapidly progress in gait disturbance.

Conclusion

The clinical result of uncemented THA for RDC was satisfactory.

Poster: 301
#1022

Severe Acetabular Reconstruction With Impaction Bone-Grafting and a Cemented or Cementless Cup in Revision Total Hip Arthroplasty

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Objective:

In revision total hip arthroplasty, bone loss due to loosening and migration of the acetabular component makes fixation of a new implant difficult because of the poor quality and quantity of the acetabular bone stock, especially for the patients who had a severe acetabular bone defect. The purpose of this study was to evaluate the short term clinical and radiographic outcomes of acetabular revision with use of an impaction bone-grafting technique and a

cemented or cementless cup combined with enhancement ring.

Materials and Methods:

Twenty-one cases (21 hips)（13 males and 8 females）had undergone total hip revision who had a severe acetabular defect (AAOS III to IV) with a mean age of 54.7 years (35-88 years) , from June 2005 to October 2009. Twelve hips （AAOS III 8 hips， AAOS IV 4 hips）had undergone second-stage revision because of periprosthetic infection after total hip arthroplasty. Nine hips（AAOS III 6 hips， AAOS IV 3 hips）had been revised for periprosthetic osteolysis. The acetabular bone defect was reconstructed with morselized compacted allograft and porous cementless acetabular component in 13 hips. Among of them, 8 hips had less than 50% of the acetabular host-bone intacted during the acetabular reconstraction. However, all of them had got the acetabular component press-fit stable fixed. Eight hips (AAOS III 1 hip， AAOS IV 7 hips） were revised with morselized and constructive allograft, the augmentation of the reconstruction with a acetabular reinforcement ring and a cement acetabular component. Clinical and radiographic results were assessed postoperation.

Results:

Nineteen patients were got followed-up from 12 to 40 months postoperatively, averagely follow-up period was 28 months. The mean Harris score was improved from 37 points (23—45 points) before revision to 92 points (87—95 points) at the final follow-up. There was no sciatic nerve injury or deep vein thrombosis. One case with femoral bone defect revision with massive bone allograft was infected postoperatively and was cured by emergency debridement, removed out the allograft and intravenous antibiotics. One case had suffered from the hip dislocation postoperatively and the dislocation was manually reducted and fixed with a brace for 3 months. No acetabular component loosening was observed during the follow-up period. The allograft bone was integrated with the host bone in all got follow-up cases.

Conclusion:

Acetabular reconstruction with use of impaction bone-grafting and a cemented or cementless acetabular component is a reliable and durable technique that is associated with good short term results in young patients with a severs acetabular bone stock defects. However, the long-term effects needs further follow-up.

Keywords:

total hip revision, acetabular bone defects, acetabular reconstruction, allograft, Cage

Poster: 302
#753

The Results of Total Knee Arthroplasty With Quadricepsplasty

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Introduction

The surgical approach for total knee arthroplasty (TKA) is commonly performed with a medial parapatellar approach when patellar eversion can be accomplished. However, this approach occasionally becomes difficult or even impossible to perform, especially in patients who had previous knee surgery or who demonstrated severe contracture. The quadricepsplasy has been reported to provide the proper surgical exposure and thus good functional outcome despite leaving moderate weakness in extension, flexion contracture, and extension lag. We investigated the clinical outcomes of the TKA with this quadricepsplasty procedure.

Materials and methods

From November 2005 to July 2010, 13 knees in 13 patients were performed TKA with quadricepsplasty. There were 3 men and 10 women with an average age of 67 years (range, 50-82 years). Four patients had degenerative joint disease and 9 had rheumatoid arthritis as their primary diagnosis. Six patients had revision arthroplasty secondary to aseptic loosening after their initial TKA and all needed the V-Y turndown to evert the patella for achieving the proper exposure. The other 7 patients, including one post-proximal tibial osteotomized knee, were

performed as primary arthroplasty, In these cases, 4 patients were performed a V-Y turndown and 3 needed a quadriceps snip. Clinical parameters, including ROM, extension lag, Knee Society score (KSS), and complications, were evaluated preoperatively and at final follow-up.

Results

The average active ROM was from 15.8 ± 16.2 ° to 67.5 ± 31.1 ° preoperatively and from 9.1 ± 11.4 ° to 85.5 ± 16.7 ° at final follow-up evaluation. The average extension lag was 3.2° at final follow-up. The average preoperative knee and function KSS were 54.3 ± 17.1 points and 48.5 ± 13.0 points, respectively, and the average scores at final follow-up evaluation were 82.3 ± 7.2 points and 58.7 ± 15.4 points, respectively.

Discussion

TKA with quadricepsplasty had improved knee range of motion significantly. This procedure gave no severe limitations when walking despite leaving flexion contracture and extension lag.

Poster: 303
#603

Early Results and Complications of Minimally Invasive UKA

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Purpose

Unicompartmental knee arthroplasty (UKA) has been proven to be the effective treatment for patients with osteoarthritis and osteonecrosis of the knee joint. We retrospectively analyzed 322 UKA cases performed in our clinic.

Methods

The subjects for this study were patients who have had UKA surgery at our clinic between January 2008 and April 2011. 322 consecutive UKAs were performed in 252 patients with minimally invasive approach. 72 male and 140 female patients, mean age at the time of surgery was 73.4(range46-93) years, were the subjects

Two kinds of implant were used, which were Oxford Phase 3 (227knees) and Zimmer Unicompartmental High Flex Knee System (95 knees).

Results

There were 19 major complications(5.9%), which were loosening (8knees), tibial plateau fracture (3knees), unknown pain (2 knees), osteonecrosis of the lateral tibial plateau(1 knee) and dislocation (5knees). 12 knees(3.7%) had to be revised. One was salvaged with polyethylene exchange and others were required conversion to total knee arthroplasty.

Conclusion

Complication rate and revision rate were similar to the previous reports. Tibial plateau fractures occurred in the both of implants. Dislocation occurred in Oxford UKA, and unkown pain occurred in Zimmer UKA. Although clinical results of UKA has been successfully stabilized with improvement in operation technique, major complications still remain not a little. UKA is technically demanding operation. Detailed understandings of complications and technical pitfalls are thought to be required in this surgery.

Poster: 304
#750

Subchondral Cysts in Dysplastic Osteoarthritic Hips -Analysis Using Three-Dimensional Computed Tomography-

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Introduction:

Bone cyst formation in hips increases as osteoarthritis worsens. Although bone cysts in hips have been described in many studies, their etiology remains unclear and under debate. The purpose of this study was to investigate the relationship between the severity of osteoarthritis and the formation of subchondral bone cysts in osteoarthritic hips.

Method:

We studied bone cysts from 208 osteoarthritic hips and 47 normal hips by computed tomography (CT) and plain radiography. We used 3D-CT to assess the distribution and size of the bone cysts and the width of the joint space in order to estimate the severity of osteoarthritis. We excluded hips that exhibited marked osteoarthritic changes because the cause of theses changes was unclear. We identified the osteoarthritic stage in these hips by using plain radiographs.

Result:

Of the 255 hips, 175 acetabula and 117 femoral heads were found to contain cysts. Further, 17 of 47 normal hips contained cysts in the acetabulum. The rate of cyst presentation in the hip increased as the joint space became narrower. The number of hips that possessed cysts in the anterior and/or middle portion was significantly higher than that in the posterior portions. Of 99 hips with a joint space thickness of less than 1 mm, all but 2 contained multiple cysts in the acetabulum and/or femoral head.

Conclusion:

Cyst formation was initially observed in the anterior acetabulum, gradually progressing to involve the entire joint, including the posterior acetabulum and the femoral head, with worsening of the osteoarthritis.

Poster: 305
#565

Alive Component

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Introduction

At this moment the main concept of treatment of severe osteoarthritis is convert a painful joint to an unnatural painless condition. Resection arthroplasty and arthrodesis are two old solutions and joint replacement is the modern technique.

Despite success of this artificial joints they follow the 20^{th} century aspects of problem solving and have many deficits. We need new approach to this problem by define new goal: *reproduce or reconstruct a new natural joint*.

This 21st century concept of treatment needs two new sciences: the first is tissue engineering that ultimately can produce any tissue, and nanotechnology that ultimately can produce any proper material. By this new sciences we can change our attitude and aim our research to restore the anatomical shape and bony structure and chondral layer of joints.

Technological requirements and available technology

The first step is ability to produce large amount of hyaline cartilage and the key point is capability of chondral cells

for further proliferation and maintaining the chondral health. At this moment the genetic technique for convert any connective tissue cell to a pluripotential cell and commit it to produce chondroblast or osteoblast is available but the further behavior of this tissue is not clear.

Another requirement is produce hyaline cartilage as a massive extended layer to cover all of surface of component, and massive extended bony layer to compensates bony defects and protect the cartilage layer, so I design the Biocomponent that has a scaffold to protect the growing new bony and chondral tissue.

This scaffold must be strong enough to tolerate and neutralized the pressure and prepare time for maturation and strengthening of bony and chondral tissue and joining the host and component bone. The other key feature is proper porosity of scaffold microstructure for adhesion of bony and chondral matrix and cells, and for bone ingrowths of host bone to pegs or stem for permanent fixing to bone.

Now we have technology of creating various macro and micro structure by carbon nanotubes that is lighter, more flexible and stronger than steel and it seems very suitable for this scaffold design.

For compatibility with usual surgical techniques, the shape of Biocomponent is design as same as usual components but it is made from carbon nanotubes scaffold that fills by bone and cartilage producing layers. Each layer consists of cells, matrix, growth factors and nutrients. A thin porous protective degradable layer must be added to surface of component for temporary protection of cartilage producing layer.

The ending part of scaffold that extending to chondral layer has important role to maintain the shape and integratio n of soft chondral matrix and it must be made of long standing biodegradable material similar to biodegradable screws.

Conclusion

The 21st century demands and developing of genetic, tissue engineering and nanotechnology lead us to develop alive natural Biocomponent instead of dead unnatural components, and the first step is changing our attitude.

Figures

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Figure 1

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#788

Monobloc Bicompartmental Knee Arthroplasty for Earlier Treatment of Combined Patello-Femoral and Medial Tibio-Femoral Knee Osteoarthritis: Preliminary Results

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INTRODUCTION:

In the past, the treatment of knee osteoarthritis was limited to unicompartmental implants (UNI) or total knee arthroplasty (TKA). No option was ideal for active patients with medial and patello-femoral compartment osteoarthritis. More recently, a bicompartmental knee replacement (BKR) system has been developed that replaces the medial tibiofemoral and patellofemoral compartments with a monolithic femoral component and medial UNI tibial component. This system also preserves both cruciate ligaments with its associated benefits. The objective of this clinical study is to evaluate preliminary results of BKR to verify indications and eventual complications and/or disadvantages.

MATERIALS AND METHODS:

From June 2009 to December 2010, 55 consecutive patients (59 knees, 21 males, average 56 years old) with

combined arthritis of the patella-femoral joint and the medial tibio-femoral compartment were recruited and treated with Journey Deuce Bi-Compartmental Knee System (Smith & Nephew, Inc, Memphis, TN). All patients had pain, but no severe limitation of range of motion (ROM) or severe deformity such as varus/valgus greater than 20°. Average body mass index was 26.7 (range 23-44). The preoperative MRI showed no damage of cartilage and meniscus of the lateral compartment, and no injury/laxity of the ACL or PCL. The onset of symptoms started from 1 to 4 years before arthroplasty. Oxford knee score, clinical KSS, KS function Score, IKDC, UCLA Activity scale were all collected and used for data analysis. Data were statistically evaluated by a paired t-test (pre vs. post-op).

RESULTS:

The mean operative time was 65.0 minutes (range: 60-95). Blood loss (mean: 280 ml, range 240-490) was significantly lower than in patients treated with MIS TKA (mean: 550 ml, range 390 -720), and none required any blood transfusion. All patients were followed from 12 to 18 months. Two weeks after surgery, most patients were able to walk with only a minimal limp and without the use of assistive devices. Patients had no patella-femoral pain nor clunking, no pain on palpation on the external compartment. There were significant differences between preoperative and postoperative IKDC and clinical and function KS scores as well as UCLA activity scale at 1, 3, 6, 12 months after surgery. Clinical parameters and ROM significantly improved: the mean preoperative ROM of 119° (range, 97°-145°) increased to 134° (range, 119°-155°) at latest follow-up. The mean KSS-F score improved from pre-op of 47.8 to post-op of 90.2. The mean preoperative anatomical alignment was 0.5° valgus and the mean postoperative anatomical alignment was 1° varus. No radiolucencies were seen at the bone-cement interface of the patella or femoral component in any cases. Conversion to TKA was performed in 2 knees, all for persistent pain at the anterior lateral aspect of the proximal tibia both for correction in light valgus (4 and 5°). Most patients reported a high level of satisfaction after implantation of BKR.

CONCLUSIONS:

BKR patients showed promising results. The main advantages of BKR are the preservation of the cruciate ligaments, the minimally invasive surgical technique,and increased stability and decreased pain compared to the TKA.