ISTA2009
The 22nd Annual Congress of the International Society for Technology in Arthroplasty
Past, Present and Future of Arthroplasty
October 22nd - 24th, 2009
Big Island, Hawaii

PROGRAM
CME Accreditation:

**Accreditation:** This activity has been planned and implemented in accordance with the Essential Areas and policies of the Accreditation Council for Continuing Medical Education through the joint sponsorship of William Beaumont Hospital and ISTA. William Beaumont Hospital is accredited by the ACCME to provide continuing medical education for physicians. William Beaumont Hospital designates this educational activity for a maximum of 25 3/4 hours.

Physicians should only claim credit commensurate with the extent of their participation in the activity.

**Disclosure Statement:** All speakers and planners have been asked to disclose any relevant financial relationships with commercial interests and a summary of this information will be made available at the time of the meeting.

Target Audience:

The Program has been designed for orthopaedic surgeons and orthopaedic researchers involved in developing new techniques and procedures in arthroplasty.

Educational Objectives:

**Objective 1:**
Critically evaluate new advances in orthopaedic arthroplasty for patients needing joint replacements so that following surgery, the pain in their joints are relieved and the implanted devices are long lasting.

**Objective 2:**
Educate orthopaedic surgeons and orthopaedic researchers in relevant new developments and techniques that will assist them in their research.

**Objective 3:**
Those attending will recognize methods to improve patient outcomes through more precise surgical procedures and better surfaces for devices.

**Objective 4:**
Surgeons involved in joint replacement should improve surgical competency by the sharing research on arthroplasty procedures by leading worldwide experts.

Disclaimer:

The products, procedures, and opinions presented at this Congress reflect the viewpoint or approach of the presenter only and are not to be attributed to the International Society for Technology in Arthroplasty.

We present such materials for informational and educational purposes only. This material is not intended to represent the only, nor necessarily the best methods or procedures appropriate for the medical situations discussed.

No reproduction of any kind, including audiotapes and videotapes, may be made of the presentations at the meeting. ISTA reserves all of its rights to such material and commercial reproduction is specifically prohibited.
SPECIAL SESSIONS - KONA BALLROOM

Thursday, October 22nd

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
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<tbody>
<tr>
<td>7:00-7:05 AM</td>
<td>Welcome by Richard D Komistek</td>
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<tr>
<td>7:05-7:48 AM</td>
<td><strong>Session 0-A:</strong> A Tribute to Three Pioneers in Arthroplasty</td>
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<td><strong>Moderator:</strong> Douglas A Dennis</td>
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<tr>
<td>A1224</td>
<td>7:10-7:22 AM Tribute to Dr John Insall</td>
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<td></td>
<td>Giles Scuderi</td>
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<tr>
<td>A-1225</td>
<td>7:22-7:34 AM Tribute to Sir John Charnley</td>
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<td></td>
<td>Dan Berry</td>
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<tr>
<td>A-1226</td>
<td>7:34-7:48 AM Tribute to Hap Paul</td>
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<td>Bargar William</td>
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<td>7:48-7:55 AM</td>
<td>Introduction: Invited Presidential Guest Speaker (Allan Houston)</td>
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Saturday, October 24th

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<th>Time</th>
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<tr>
<td>7:00 - 8:00 AM</td>
<td><strong>Open Session</strong></td>
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<td><strong>CEO Roundtable Discussion</strong></td>
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<td><strong>Moderator:</strong> Richard D Komistek Douglas A Dennis</td>
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<td>Jeff Binder</td>
<td>- Biomet</td>
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<td>Mike Mahoney</td>
<td>- DePuy</td>
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<td>Leslie Cross</td>
<td>- DJO</td>
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<td>Mike Tuke</td>
<td>- Finsbury</td>
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<td>Joe Devivo</td>
<td>- Smith &amp; Nephew</td>
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<td>Gary Henley</td>
<td>- Wright Medical Technologies</td>
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<td>Jeff McCaulley</td>
<td>- Zimmer</td>
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<tr>
<td>12:00 - 1:00 PM</td>
<td><strong>Lunch Session</strong></td>
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<td><strong>Awards Session (Sponsored by Finsbury)</strong></td>
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<td>Student Biomechanics Award</td>
<td>12:00-12:10 PM In Vivo Knee Kinematics: Is Ethnicity or Gender an Influencing Factor? Filip Leszko</td>
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<td>Hap Paul Award</td>
<td>12:10-12:25 PM New Bactericidal Allogeneic Bone Constructs Offer Clear Advantages Over Elution Technologies Constantinos Ketonis</td>
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<tr>
<td>Lifetime Achievement Award</td>
<td>12:25 PM The E-Knee- Concept, Clinical Application and Data Retrieval Clifford Colwell</td>
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ALL SPECIAL SESSIONS ARE HELD IN THE KONA BALLROOM
SEE ROOM MAP ON PAGE 5
Thursday, October 22, Morning Oral Sessions 8:00AM-11:55AM ISTA 2009

Session 1A: 8:00-8:55 AM

**Orthopaedic Imaging**

A-207
State of Orthopaedic Imaging Relative to Joint Replacement

A-620
Appropriate Entry Point of Intramedullary Guides for Femur in Total Knee Arthroplasty: Using Three-Dimensional Digital Templating Software "Athens"

A-815
2D-8:21 AM

E-544
In Vivo Imaging of Cells Using Ultrasound with Ultrasound Microscope

A-147
Automatic Segmentation of Osteoarthritic Knee Joints in CT Volumes Using Statistical Bone Alignments

A-273
8:27-8:33 AM

A-168
Automatic Three Dimensional Distal Radius Analysis Using Statistical Atlases

A-559
8:39-9:55 AM

**SESSION DISCUSSION**

Session 2A: 9:00 - 9:55 AM

**Session Discussion on Complex Joint Arthroplasty**

A-1022
A Minimum 2 Years Experience with DePuy AAM Ceramic Components in THR Using Standard and Enhanced Femoral Heads

A-532
Clinical Results of Ceramics in THR

A-623
Correlating Retrieval Studies of Biolox-Delta (1-7 Years) and Biolox-Forte (1-22yrs) with Hip Simulator Wear Studies

A-694
The Squeaking Hip: An Update

A-993
Association Between Squatting and Implant Design and Material in Ceramic-Ceramic Total Hip Arthropathy

A-1208
A Prospective Follow-Up Study on the Clinical and Radiological Outcome of the Mulligan Long Stem Total Knee System with Biolox Delta Ceramic Component

A-705
9:55-10:10 AM

**SESSION DISCUSSION**

Session 3A: 10:10 - 10:55 AM

**Arthroscopic Knee Surgery**

A-682
Knee Forces During Downhill Skiing after Total Knee Arthroplasty

A-1049
The Anatomic Rationale for Guided Motion Knee Arthroplasty

A-1017
Advanced Osteoarthritis Gait Kinematics and Kinetics

A-849
10:55-11:10 AM

**SESSION DISCUSSION**

Session 4A: 11:10 - 11:55 AM

**Hip Arthroplasty**

A-148
In Vivo Determination of THA Kinematics for Subjects Having Two Different Surgical Procedures

A-118
In Vivo Assessment of Hip Kinematics During Four Activities

A-981
In Vitro and In-Vivo Investigations of the Impaction and Pull-Out Behavior of Metal Backed Acetabular Cups

A-113
The Influence of the Femoral Head on the Forces Acting on the Hip after Total Hip Replacement

A-865
Asymmetrical Bony Geometry at the Antero-Lateral and Postero-Lateral Femoral Head Joints

A-895
Two Different Approaches in THR A Gait Analysis Study

A-1148
11:55-12:10 AM

**SESSION DISCUSSION**
<table>
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<tr>
<th>Time</th>
<th>Session</th>
<th>Title</th>
<th>Speaker(s)</th>
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<tbody>
<tr>
<td>1:00 PM-1:55 PM</td>
<td>Session 6-A</td>
<td>Computational Tools for Design Phase Evaluation of Total Knee Replacement Kinematics</td>
<td>MA Baldwin, C Clary, LP Maletsky, PJ Rullkoetter</td>
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<td>Chain Entanglements and UHMWPE Wear Performance</td>
<td>JJ Wu, QQ Wang, I Khan</td>
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<td>New Surgical Treatment Using Docking Nail for Periprosthetic Femoral Fracture After Total Hip Replacement</td>
<td>R Valentini, B Martinelli</td>
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<td>Hip Resurfacing Arthroplasty: The Effect of Anterior and Posterior Notching on Fracture Resistance</td>
<td>KF Mohammad</td>
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<td>Early Clinical Evaluation of a Contoured Focal Resurfacing Prosthesis System (Hemicapa®) in UK Patients</td>
<td>PJ Tong, SX Zhang, HT Jin, L Chen, WF Ji, J Li</td>
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<td>Management of Failed Internal Fixation of Trochanteric Hip Fractures Using Cementless Modular Hip Arthroplasty</td>
<td>M Takagi, S Kobayashi, K Sasaki, Y Takakubo, H Kawaji, Y Tamaki, M Ishi</td>
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<td>3:00 PM-3:55 PM</td>
<td>Session 7-C</td>
<td>Total Hip Arthroplasty: The Effect of Body Mass Index, Acetabular Morphology, and Bone Quality on Stresses Developed in Cement Mantles</td>
<td>RH Kim, DA Dennis, CC Yang, BD Haas</td>
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<td>Session 7-C</td>
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<td>5:00 PM</td>
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<td>Session</td>
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<tr>
<td>A-12147</td>
<td>Using Knee Navigation to Plan and Execute Deformity Management</td>
<td>7:00-7:10 AM</td>
<td>JN Argenson, S Parratte, X Fletcher, JM Aubaniac</td>
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<tr>
<td>A-705</td>
<td>Computer Assisted Total Knee Arthroplasty for Significant Tibial Deformity</td>
<td>7:16-7:22 AM</td>
<td>L Puri, RR Shah, G Strohmeyer</td>
</tr>
<tr>
<td>A-947</td>
<td>Accuracy of Robotically Assisted UKA</td>
<td>7:36-7:42 AM</td>
<td>TM Coon, MD Driscoll, S Horowitz, MA Conditt</td>
</tr>
<tr>
<td>A-639</td>
<td>Early Clinical Outcomes of Robotic-Assisted UKA Compared with Conventional Manual Onlay Components</td>
<td>7:48-7:54 AM</td>
<td>RK Sharma, Y Kumar, R Kumar, S Agarwal</td>
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<tr>
<td>A-12158</td>
<td>Should I Use Navigation?</td>
<td>8:00-8:10 AM</td>
<td>Shuichi Matsuda</td>
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<td>A-1170</td>
<td>Periprosthetic Delivery of Erythromycin in a Rat Model of Aseptic Loosening</td>
<td>8:06-8:12 AM</td>
<td>A-605</td>
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<td>A-764</td>
<td>Tracking Back In Vivo Wear Kinematics from the Surface of Retrieved UHMWPE Tibial Components by Means of Polarized Raman Spectroscopy</td>
<td>8:28-8:34 AM</td>
<td>A Masini, GE Bellina</td>
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<tr>
<td>A-1153</td>
<td>Allogenic Bone Grafts with Covalently Tethered Antibiotics Prevent Bacterial Attachment and Biofilm Formation</td>
<td>8:34-8:40 AM</td>
<td>GA Higgins, J Tunggall, P Kuzyk, E Schemitsch, JP Waddell</td>
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<tr>
<td>A-1069</td>
<td>Optimal Duration of Continuous Femoral Nerve Block After Total Knee Arthroplasty</td>
<td>8:42-8:48 AM</td>
<td>PJC Heesterbeek, NLW Keijsers, N Verdonschot, AB Wymenga</td>
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<tr>
<td>A-1212</td>
<td>Metal on Metal Hip Arthroplasty: Where Are We in 2009?</td>
<td>9:10-9:16 AM</td>
<td>Dae-Kyung Bae</td>
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<tr>
<td>A-679</td>
<td>Metal Transfer Commonly Found on Retrieved Ceramic Heads Can Occur with Single Rim Contact During Surgery</td>
<td>9:48-9:54 AM</td>
<td>TR Yoon, KS Park, K Thevarajan, YJ Cho, HK Yang</td>
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<tr>
<td>A-722</td>
<td>Knee Kinematics in Patients with Bilateral TKA of Two Designs During Maximum Flexion Activities</td>
<td>9:54-9:55 AM</td>
<td>JH Currier, IM Tomek, BH Currier, JC Huot, MB Mayor, DW Van Citters</td>
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<tr>
<td>A-118</td>
<td>Variability and Reproducibility of Range of Motion for Tri-Lobe vs Ball &amp; Trough Cervical Total Disc Designs</td>
<td>10:27-10:33 AM</td>
<td>HW Kang, JB Kim, SJ Lyu</td>
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<tr>
<td>A-112</td>
<td>How to Improve Tibial Alignment without the Use of Navigation</td>
<td>10:45-10:55 AM</td>
<td>SD Cho, YS Youm, CY Jung, KB Park</td>
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**QUEENS**

Friday, October 23, Morning Oral Sessions 7:00AM-11:00AM ISTA 2009
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<tr>
<th>Time</th>
<th>Session</th>
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<tr>
<td>8:00 - 8:55 AM</td>
<td>Session 13-C: Future of Knee Mechanics: Techniques, Modeling and the Patient</td>
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<tr>
<td>8:00 - 8:09 AM</td>
<td>Stephen Cook&lt;br&gt;FUTURE OF KNEE MECHANICS: TECHNIQUES, MODELING AND THE PATIENT</td>
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<tr>
<td>8:09 - 8:10 AM</td>
<td>David Blaha&lt;br&gt;Future of Knee Mechanics: Techniques, Modeling and the Patient</td>
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<tr>
<td>8:09 - 8:10 AM</td>
<td>Mohamed Mahfouz&lt;br&gt;Future of Knee Mechanics: Techniques, Modeling and the Patient</td>
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<tr>
<td>8:10 - 8:11 AM</td>
<td>Analysis of Normal and Replaced Knee Kinematics in an Isometric Extension Model</td>
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<td>8:11 - 8:12 AM</td>
<td>Preclinical Evaluation of a Novel Pyrocarbon Reconstruction Device For Focal Defects of the Knee</td>
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<td>8:12 - 8:13 AM</td>
<td>TKR: Changing Patients and Demographics: Implications for Future Implant Needs</td>
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<td>8:13 - 8:14 AM</td>
<td>Differentiation of Adult Human Adipose-Derived Stem Cells into Articular Chondrocytes Is Achieved by Overexpression of the BMP Receptor 1A</td>
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<tr>
<td>8:14 - 8:15 AM</td>
<td>Is There an Association Between Articular Cartilage Changes and Type of Meniscal Tear?</td>
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<tr>
<td>8:15 - 8:16 AM</td>
<td>Application of Non-Destructive Evaluation Techniques for the Assessment of Bone Cement Microcracking During Fatigue</td>
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<td>8:16 - 8:17 AM</td>
<td>What Hand the Cane?</td>
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<td>8:17 - 8:18 AM</td>
<td>Session 14-C: Approaches and Techniques to Predict Future Outcomes</td>
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<tr>
<td>8:18 - 8:19 AM</td>
<td>Ray Wasielewski&lt;br&gt;Approaches and Techniques to Predict Future Outcomes</td>
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<td>8:19 - 8:20 AM</td>
<td>Thomas Blumenfeld&lt;br&gt;Approaches and Techniques to Predict Future Outcomes</td>
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<tr>
<td>8:20 - 8:21 AM</td>
<td>Balanced Resection vs Measured Resection: The Clinical Importance of Soft-Tissue Balancing During TKA</td>
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<td>8:21 - 8:22 AM</td>
<td>Transposition Ostectomy of the Acetabulum for Advanced Stage Osteoarthritis of the Hips Due to Acetabular Dysplasia</td>
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<td>8:22 - 8:23 AM</td>
<td>Which Variables Determine the Outcome of Revision Total Knee Arthroplasty?</td>
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<td>8:23 - 8:24 AM</td>
<td>What Does the Future Hold for Shoulder Arthroplasty?</td>
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<tr>
<td>8:24 - 8:25 AM</td>
<td>William Capello&lt;br&gt;What Does the Future Hold for Shoulder Arthroplasty?</td>
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<td>8:25 - 8:26 AM</td>
<td>Giles Scuderi&lt;br&gt;What Does the Future Hold for Shoulder Arthroplasty?</td>
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<td>8:26 - 8:27 AM</td>
<td>Ian Clarke&lt;br&gt;What Does the Future Hold for Shoulder Arthroplasty?</td>
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<td>8:27 - 8:28 AM</td>
<td>Two Year Outcomes of Robotically Guided UKA</td>
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<td>8:28 - 8:29 AM</td>
<td>What Is an Acceptable Level of Metal Ions After Metal-on-Metal Hip Resurfacing</td>
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<td>8:29 - 8:30 AM</td>
<td>Routine Clinical Outcome Assessment of the Shoulder is Valid Using Inertia Sensor Based Motion Analysis</td>
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<td>8:30 - 8:31 AM</td>
<td>Scapulohumeral Rhythm of Reverse Shoulder Arthroplasties During Weighted and Unweighted Shoulder Abduction</td>
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<td>8:31 - 8:32 AM</td>
<td>What Is the Most Accurate Method for Measuring the Migration of a Metal-on-Metal Hip Resurfacing Prosthesis?</td>
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Session 17-A: 1:00 - 1:55 PM
KONA

Moderators: Robert Booth, Raymond Kim

Knee Mechanics: Can Today’s Learned Concepts Benefit Future Outcomes?

A-483 1:00-1:06 PM
Evaluation of TKA Performed with and without Computer Navigation: A Blinded TKA Study

D. Johnson, K. Schuberth

A-773 1:06-1:12 PM
Total Knee Arthroplasty in Bladder Ostomy

K. Gott, S. Kiyono

A-199 1:12-1:18 PM
Relationship between the Kinematic/Position Axes of the Knee and Commonly Used Anatomic Axes

D. Roehrs, D. Rorer, C. Bier, K. Limon, P. Brown, M. Carroll

A-1218 1:18-1:24 PM
Keys to OR Efficiencies

R. Booth

A-228 1:24-1:30 PM
Biomechanical Analysis of Prosthetic Cerebellar Ligament Retaining High Flexion Total Knee Arthroplasty

G. Datta, M. E. E. El MKawy

A-227 1:30-1:36 PM
Do Preclinical In vivo Polyethylene Wear in Knee Simulator Studies?

J. V. E. V. H. Chue, S. V. N. Y. H. Chua

A-1036 1:36-1:42 PM
The Effect of Ligament Balancing on the Femoral Component and Assessing the Accuracy of Balancing in Revision of Extensor Gaps in Total Knee Arthroplasty

Q. Zhou

1:42-1:55 PM
PANEL DISCUSSION

Session 17-B: 1:00 - 1:55 PM
QUEENS

Moderators: David Stulberg, Fred Cushner

Exciting Minimally Invasive Technologies and Techniques for the Future

A-768 1:00-1:06 PM
Intravenous Embolic Events During Total Knee Arthroplasty: Use of Pulsatile Saline versus Carbon Dioxide Lavage

J. LeFort, R. Reddick, D. McRostie, D. Boyer, P. Scanlon

A-1118 1:06-1:12 PM
Total Knee Arthroplasty: Is It Safe in Obesity?

A. Oh, G. Gruppo

1:12-1:18 PM
The Effect of Single Use Instrumentation on Operating Room Efficiency for Total Knee Arthroplasty: A Multicenter Study

K. Leavy

1:18-1:24 PM
Effect of Surgical Approach on Gait Following Total Knee Arthroplasty

D. W. A. James, K. J. van der Beek, M. J. Almekinders, M. J. Pickard, M. J. Brooker

1:24-1:30 PM
Minimally-Invasive Management of Knee Osteoarthritis using Component Arthroplasty Combination and Association with Osteotomy

J. Amstutz, S. Peres, J. A. G. Aragon

1:30-1:36 PM
Radiographic Assessment of the Short Hip Stem using a Novel Staining System

R. A. Desai

1:36-1:42 PM
Minimally Invasive, ACL Substituting Knee Replacement in Younger Patients

W. Makowiec

1:42-1:48 PM
PANEL DISCUSSION

Session 17-C: 1:00 - 1:55 PM
KINGS

Moderators: John Currier, Suichi Matsuda

Innovative Future Technologies

A-105 1:00-1:06 PM
The Use of Hip Motion Simulations to Create New Hip Navigation Systems

R. Theurer

A-1049 1:06-1:12 PM
A Simple, Laser-Guided System for Prescribing Anterolateral Cup Osteotomization Angle in Total Hip Arthroplasty

W. McLean, J. Price, R. Siddell, J. Fergie, M. Macdonald, A. McIlroy

1:12-1:18 PM
Wireless Signal Propagation in the Operating Room and Its Implications on Surgical Navigation, Digital Communication, and Minimally Invasive Techniques

M. Kato, M. Matsumura

1:18-1:24 PM
Glove, Screen and Droplet Effects on Intravenous Bacterial Contamination

W. Ward, J. Cooper, D. Lippman, J. A. Bass, R. Kalvinder, A. Sheehy

1:24-1:30 PM
Patient-Specific 3D Bone Model Reconstruction for X-Ray Fluoroscopy

J. Shih, M. Matsumura

1:30-1:36 PM
Accuracy of Cup Position Using Image-Free Navigation System for Developmental Dysplasia of Hip

S. Shih, J. Oh, M. Mineo, T. Nishimura, Y. Ohtani, I. Tohno, K. Tanaka, K. Kikura

1:36-1:42 PM
Lateral Epicondyle Osteotomy using Computer Navigation in Total Knee Arthroplasty for Rigidity Defect

M. Morita, G. Sheehy

1:42-1:48 PM
PANEL DISCUSSION

Session 18-A: 2:00 - 2:55 PM
KONA

Moderators: Laurent Sedel, Clifford Cowell

Understanding Joint Pathologies, New Concepts and Strategies:

B. Mohan, D. J. Roth, S. M. S. Suryanarayanan

A-824 2:00-2:06 PM
Basic Design for Joint Prostheses of Low Friction and Low Wear with Hydrogel Artificial Cartilage

T. Meng, A. Nakashima, T. Sone, S. Ito, S. Satomi

A-726 2:06-2:12 PM
Strategy for Femoral Lift Up in TKA through Direct Anterior Approach: Cadaver Study and Clinical Experiences

M. Matsui, H. Ishikawa, Y. Hashimoto, Y. Kasuga, T. Kaneko, K. Kato

A-46 2:12-2:18 PM
Polyurethane Form as Artificial Cartilage for Joint Replacement


A-1105 2:18-2:24 PM
Long-Term Hydrogel Polymers for Articular and Osseous Surfaces for Orthopaedic Implants

W.van der Beek, M. van der Heide, L. van der Graaf

A-1107 2:24-2:30 PM
Metal Ions in Conjunction with Patient Activity: Hip Resurfacing Patients at Various Stages of Follow-Up

C. M. W. Verbeek, D. C. M. ten Hove, E. H. J. M. van der Heijden

A-337 2:30-2:36 PM
Tribological and Material Analysis of Retrieved Alumina and Zirconia Ceramic Ball Heads. Correlation with Polyethylene Wear after Total Hip Replacement

T. E. G. J. E. van der Heijden

A-554 2:36-2:42 PM
The Brueck Tantalum Monobloc Acetabulum—Results to 10 years

A. Querry, B. Lewis

2:42-2:48 PM
PANEL DISCUSSION

Session 18-B: 2:00 - 2:55 PM
QUEENS

Moderators: Kevin Garvin, Chitrangan Ranawat

TKA: N’ 3 Just Some Grabs

A-1221 2:00-2:06 PM
How to Obtain Tissue-Balancing in TKA

J. Taylor

A-1105 2:06-2:12 PM
Soft Tissue Tension Technique to Self Assessment of Femoral Rotation in Total Knee Arthroplasty: Early Experience with MRI (Radiouclide Imaging) Techniques

B. Sturman, W. Macon

A-1178 2:12-2:18 PM
Muscle Isokinetik Modeling Using an Explicit Finite Element Framework

C. G. Coop, S. Bol, F. Ballavick

A-100 2:18-2:24 PM
Relationship Between Intercondylar Osteophytes and Cruciate Ligaments in Osteoarthritic Knees

M. Nishimura, H. Nakashima, H. Minato, Y. Konagai, H. Takashima, H. Inoue

A-1107 2:22-2:28 PM
A Graft Design for Joint Replacement Design


2:28-2:34 PM
Learning Curve in Minimally Invasive Total Knee Arthroplasty as Measured by Post-Operative Complication Rate

G. Jones, J. Hellenbrand

A-1117 2:34-2:40 PM
PANEL DISCUSSION

Session 18-C: 2:00 - 2:55 PM
KINGS

Moderators: Jean Louis Briand, Paul Rulkowter

Future Technologies: Can They be of Benefit?

A-529 2:00-2:06 PM
Motion Tracking Using Microscopic Wireless Membrane Sensing Units

G. To, M. Matsuda

A-419 2:06-2:12 PM
Real-Time Monitoring of Progressive Damage During Loading of Simplified Total Hip Stem Construct Using Embedded Acoustic Emitter Sensors

M. Matsumoto, M. Tuma, E. M. R. M. Brown

A-980 2:12-2:18 PM
Wireless Ground Reaction Forces and Locations Across the Foot using In-shoe Mems Pressure Sensors

E. Frangou, M. Matsuda

A-1125 2:18-2:24 PM
Safety: Cleaning Method of Osteophytes Plate and Score for Possibility Reuse in Developing Countries

R. Meghij, C. Hulse, H. van der Mei, H. Brushek, J. Hesse

A-985 2:22-2:28 PM
A Novel Method: Ceramic-on-Ceramic Joint in TKA: A New Solution to Reduce the Risk of Osteolysis and Subluxation

B. Meunier, J. Laurence, J. Fisher, L. Kroon

2:28-2:34 PM
Determination of Polyethylene Wear in Knee Replacement with Ceramic-on-Ceramic Contact Using a Newly Developed Wear Test Methodology

S. Shimazaki, N. Nakachi, H. Mitsuyama, Y. Konaga, N. Yoshino, T. Matsushita, T. Nishino

A-780 2:34-2:40 PM
PANEL DISCUSSION

3:00 PM
Congress Ends
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<thead>
<tr>
<th>Time</th>
<th>Kona Ballroom</th>
<th>Queen's Ballroom</th>
<th>King's Ballroom</th>
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<tbody>
<tr>
<td><strong>WED</strong></td>
<td>Presidential Reception</td>
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<tr>
<td>7:05 AM</td>
<td>Opening Session 0-A: A Tribute to Three Pioneers in Arthroplasty</td>
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<tr>
<td>8:00 AM</td>
<td>Session 1-A: Orthopedic Imaging</td>
<td>Session 1-B: THA: Clinical Results</td>
<td>Session 1-C: Total Shoulder Arthroplasty</td>
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<tr>
<td>9:00 AM</td>
<td>Session 2-A: Update on Ceramics in Total Joint Arthroplasty</td>
<td>Session 2-B: TKA: Patellar Issues</td>
<td>Session 2-C: Total Knee Arthroplasty: Potpourri</td>
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<td><strong>THURSDAY</strong></td>
<td><strong>BREAK</strong></td>
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<tr>
<td>10:00 AM</td>
<td>Session 3-A: Knee Kinetics &amp; Kinematics</td>
<td>Session 3-B: THA: Component Orientation and Surgical Accuracy</td>
<td>Session 3-C: Fixation: Theory and Practice</td>
</tr>
<tr>
<td>11:00 AM</td>
<td>Session 4-A: Hip Mechanics Analyses</td>
<td>Session 4-B: Effects of Wear Debris</td>
<td>Session 4-C: Short Stems in THA</td>
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<tr>
<td>12:00 PM</td>
<td>Sponsored Lunch 1 - Synvasive</td>
<td>Sponsored Lunch 2 - Ceramtec</td>
<td>Sponsored Lunch 3 - DePuy</td>
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<td>1:00 PM</td>
<td>Session 5-A: TKA: Experience and Design Factors</td>
<td>Session 5-B: Risk Factors in Arthroplasty</td>
<td>Session 5-C: The Diseased Joint: Non Arthroplasty Options</td>
</tr>
<tr>
<td>2:00 PM</td>
<td>Session 6-A: Hip Resurfacing: Influencing factors, Outcomes and Concerns</td>
<td>Session 6-B: Knee Mechanics</td>
<td>Session 6-C: Fracture Management</td>
</tr>
<tr>
<td>3:00 PM</td>
<td>Session 7-A: Total Hip Arthroplasty</td>
<td>Session 7-B: Preoperative Evaluation and Clinical Results of TKA</td>
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<td>4:00 PM</td>
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<td>Poster Session</td>
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<td><strong>FRIDAY</strong></td>
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<td>7:00 AM</td>
<td>Session 8-A: UKA: Clinical Results and Techniques</td>
<td>Session 8-B: Managing Deformities</td>
<td>Session 8-C: Revision THA</td>
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<tr>
<td>8:00 AM</td>
<td>Session 9-A: Mechanics and Mechanisms of the Knee</td>
<td>Session 9-B: Should I use Navigation?</td>
<td>Session 9-C: Complication Management</td>
</tr>
<tr>
<td>9:00 AM</td>
<td>Session 10-A: Update on Alternative Bearings in THA</td>
<td>Session 10-B: Factors Affecting Total Hip Arthroplasty</td>
<td>Session 10-C: In Vivo Kinematics</td>
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<td>10:00 AM</td>
<td><strong>BREAK</strong></td>
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<tr>
<td>10:15 AM</td>
<td>Session 11-A: Implant Alignment</td>
<td>Session 11-B: Ethnic and Gender Issues in Arthroplasty</td>
<td>Session 11-C: Spine Mechanics</td>
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<tr>
<td>11:00 AM</td>
<td>Session 12-A: Update on the &quot;Squeaking THA&quot;</td>
<td>Session 12-B: TKA: Outcomes, Treatments and Methodologies</td>
<td>Session 12-C: THA Wear</td>
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<td>12:00 PM</td>
<td>Sponsored Lunch 1 - Biomet</td>
<td>Sponsored Lunch 2 - Zimmer</td>
<td>Sponsored Lunch 3 - Otismed</td>
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<td>6:30 PM</td>
<td>Gala Dinner</td>
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<td><strong>SATURDAY</strong></td>
<td><strong>BREAK</strong></td>
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<tr>
<td>7:00 AM</td>
<td><strong>OPEN SESSION:</strong> CEO Roundtable Discussion</td>
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<tr>
<td>9:00 AM</td>
<td>Session 14-A: Use of Digital Force Technology to Balance Ligaments in TKA</td>
<td>Session 14-B: Approaches and Techniques to Predict Future Outcomes</td>
<td>Session 14-C: The future of alternative bearings in orthopaedics</td>
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<td>10:00 AM</td>
<td><strong>BREAK</strong></td>
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<tr>
<td>1:00 PM</td>
<td>Award Session (lunch provided)</td>
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<tr>
<td>2:00 PM</td>
<td>Understanding Today's Alternative Bearings For Tomorrow's Success</td>
<td>Session 18-B: TKA: Not Just Bone Cuts</td>
<td>Session 18-C: Future Technologies: Can they be of Benefit?</td>
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**CONGRESS ADJOURNED**
ISTA 2009
October 22-24, 2009
Hilton Waikoloa Village – Big Island – Hawaii, USA

Congress Chairs:
Douglas Dennis, M.D.
Richard Komistek, Ph.D.
ADVANCED OSTEOARTHRITIC GAIT KINEMATICS AND KINETICS

D.J. Jacofsky, J.D. McCamley, M. Bhowmik-Stoker, M.C. Jacofsky, M.W. Shrader,
The Core Institute, Sun City West, AZ, USA, Sun Health Research Institute, Sun City, AZ, USA

Previous studies (Chen et al., 2003; Kaufmann et al., 2001) have shown that persons with osteoarthritis (OA) walk more slowly with lower cadence, have lower peak ground reaction forces and load their injured limb at a lower rate than healthy age matched subjects. However, another study (Mündermann et al., 2005) found that patients with severe bilateral OA loaded their knee joint at a higher rate. They also found these patients had higher knee adduction moments and lower hip adduction moments. It has been reported (McGibbon and Krebs 2002) that when subjects with knee OA are required to walk at the same speed as healthy subjects they generate more power at the hip joint to help overcome reduced knee power and aid in the advancement of the leg prior to the swing phase of the gait cycle. Myles et al. (2002) reported that patients with knee OA have reduced knee range of motion during walking. This paper presents detailed kinematic and kinetic data collected on a large group of patients with advanced knee osteoarthritis to show the differences in the gait of these patients just prior to surgery compared with age-matched control group.

This study was approved by the Sun Health Institutional Review Board. Subjects volunteered to participate in the study and signed informed consent prior to testing. Subjects were excluded if the had significant diseases of the other joints of the lower extremity or a diagnosed disorder with gait disturbance. Motion data was captured using a ten-camera motion capture system (Motion Analysis Corp., Santa Rosa, CA). Three-dimensional force data was recorded using four floor embedded force platforms (AMTI Inc., Watertown, MA). Patients were asked to walk at a self selected speed along a 6.5 meter walkway. A minimum of five good foot strikes for each limb were recorded. 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). Statistical analysis was performed using SPSS 14.0 software (SPSS Inc., Chicago, IL) ($\alpha = 0.05$).

Eighty-six patients (71 ± 7 years) along with sixty-four control subjects (65 ± 10 years) volunteered to participate in the study. All measured temporal and spatial parameters showed significant differences between the OA patients and the control group. The OA patients were found to walk at a significantly lower velocity ($p<.01$) and cadence ($p<.01$) using a wider step width ($p<.01$) than the control subjects. Patients had their injured knee significantly more flexed at foot strike ($p<.01$) but flexed the knee significantly less during swing ($p<.01$) when compared to the control group. Patients had significantly higher knee flexion angles as well as hip flexion and abduction angles during stance. Knee varus angles were significantly higher for the OA patients during stance ($p<.01$) but not during swing when compared to the control group.

Significant increases in pelvic tilt and pelvic obliquity were measured during the stance phase. Hip abduction angles during stance were significantly lower for the OA group. Patients generated significantly lower vertical ground reaction forces during stance ($p<.01$) while sagittal plane kinetic analysis showed significantly lower external knee flexion moments ($p<.01$) and knee power generation ($p<.01$) during this phase of the gait cycle. Analysis of frontal plane angles showed OA patients had a significantly higher maximum knee varus angle during stance.
as well as generating a higher external knee varus moment (p=.03) during this phase of the gait cycle.

Changes in gait measured in this study support and enhance findings from previous studies. OA patients appeared to walk with a more crouched posture with higher knee and hip flexion angles through mid stance. This along with lower velocity and cadence and a larger step width would indicate a desire for more stability while walking. Patients also flexed their knees more at foot strike in an attempt to absorb the forces generated during weight acceptance. While knee flexion angles measured for the OA group were similar to the control subjects during the initial period of stance, the OA patients did not extend their knees as much during mid stance indicating a desire to reduce the angular rotation of the knee while in single support. Changes measured in frontal plane angles of the hip and pelvis may be an attempt to compensate for the different angles generated by the knee during stance. The differences in hip and knee angles measured during stance for patients and controls allowed patients to have reduced peak external knee flexion moments during initial stance but a higher knee flexion moment at mid stance. The reduction in knee angular change during stance and the reduced cadence meant power absorption during early and late stance and generation during mid stance was much lower for the OA patients than the control group. All the changes noted appear to be designed to limit the movement of the knee joint while loaded and reduce the peak loads in an effort to reduce pain at the affected joint while at the same time increase stability during gait. These data show the differences that exist between the gait patterns of patients with advanced osteoarthritis and healthy age- matched persons and highlight the changes that are necessary following knee replacement surgery and rehabilitation to return the gait of these patients to normal.

References:
Introduction: Wear performances and fracture toughness of the alumina-matrix composite (AMC) Biolox-delta® are pointed out in the literature. Clinical and radiological studies are needed to assess the potential benefits of AMC / AMC bearing surfaces. The aim of this study is the prospective evaluation of complications and risk factors in patients implanted with AMC liners and 32 - 36 mm AMC femoral heads.

Methods: 323 consecutive patients were included prospectively since 2006.
243 were implanted for primary surgery with 32 or 36 mm ball heads for a 10-12, 6° tapers. In 80 cases, we used 32 and 36 mm Delta® sleeved heads (M,L,XL) for the adaptation on 12-14, 5°43 tapers or 10-12, 6° tapers (acetabular revisions in absence of stem exchange, or to increase the length of the femoral neck and the offset).
All the clinical and radiological files were evaluated at a minimum 2 years follow-up with a special attention for the fracture risk and squeaking. Radiological data were analysed using Dicomesure® software.

Results: We did not face any significant problem in this series. No fracture occurred. No abnormal wear or implants migration could be detected. We did not observe squeaking phenomenons. 2 THP were revised for septic complications; the retrivals were analysed for transformation studies (Xray diffraction method XRD). The phase transformation tetragonal to monoclinic was mild, in accordance with previous experimental data.

Conclusion: The limitation of this study is its short follow-up; nevertheless the clinical results are in accordance with the previously published experimental data.
The purpose of this study was to review the clinical and radiographic outcome in THRs done following acetabular fractures (fx). All patients undergoing conversion THR after previous acetabular fx between 1990 and 2006 at a single institution were identified. Clinical evaluation was done using the Harris hip scale. Radiographic evaluation was done using the system proposed by the Hip society. THRs as part of initial treatment for acute acetabular fx were excluded.

There were 90 THRs (90 patients) performed in patients previously treated for an acetabular fracture. At the time of their acetabular facture, 67 had been treated with ORIF, 12 were treated with closed or limited open reduction and percutaneous fixation, and 11 were treated without surgery. The mean age at injury was 43.7 years, (range, 14 - 79). 68 patients sustained their fx from a high-energy mechanism (MVC, MPC, or MCC). Three patterns accounted for 52% of the fx: transverse posterior wall (20), both column (18), and T-Type (9). Associated pelvic fractures were present in 14 patients. Associated ipsilateral proximal femur fractures were present: femoral head (four), femoral neck (five), and femoral shaft (three). Among those treated with ORIF, marginal impaction was noted in 31 and osteochondral head damage in 32 hips.

The mean interval between injury and THR was 42 months (range, two months to 32 years). Cementless fixation was used in 81 of the 90 cups. Similarly, cementless stems were used in 80 stems. Bone graft was necessary in 26 patients (17 autograft, nine allograft). Two cases each required pelvic augments and reinforcement cage, respectively. Additional findings at THR included: femoral head erosion (53 hips), femoral head osteonecrosis (37 hips), osteonecrosis of the acetabulum (22 hips), and fx nonunion (six hips). The average cup abduction angle was 440 (range, 28 to 60), the average cup height was 24 mm (range, 10 to 42), and the average medialization distance was 23 mm (range, 5 to 48). The mean EBL was 810 ml and mean operative time was 195 minutes. The mean F/U was 36 months (range, 6 months to 17 years). The median Harris hip score was 89 at the most recent F/U. Fifteen revisions (16%) have been done: aseptic loosening (seven hips), recurrent dislocation (six hips) and infection (two hips).

Five of the six revisions for recurrent dislocation were performed in patients who had a posterior approach for both their acetabular fracture treatment and their THR. No revision was done in those who had been initially with percutaneous fixation. There was no infection in those who had been initially with percutaneous fixation either from the fx treatment or the THR. In contrast, 14 ORIF patients were complicated by infection. One of these developed infection following THR.

Our data support the clinical efficacy and mid-term durability of THR in this patient group. Aseptic loosening and recurrent dislocation remain the primary reasons for revision surgery.
THE EFFECT OF MODERN TOTAL KNEE ARTHROPLASTY ON MUSCLE BALANCE AT THE KNEE
W. L. Buford, Jr., F. M. Ivey, D. M. Loveland, C. W. Flowers
Department of Orthopaedic Surgery and Rehabilitation, University of Texas Medical Branch, Galveston TX 77555

Past work in our laboratory identified the generalized effects of TKA on muscle balance, showing a significant change in relative moment generating potential balance favoring flexion and external rotation relative to the normal (intact) knee (for both PCL sparing and posterior stabilized TKA). However, there are no reliable data descriptive of the effect of any single prosthesis. This study hypothesized that using a modern TKA (Smith Nephew Journey) and implantation by a single surgeon in five fresh cadaver specimens would result in change in muscle balance similar to the earlier results for posterior stabilized TKA.

Using the tendon excursion-angular motion method \( MA = \frac{dr}{d\Theta}, r \) is excursion, \( \Theta \) is joint angle in radians), moment arms of all muscles at the knee were determined for each of three conditions (intact, ACL-deficient, and prosthesis). The moment arms were then multiplied by the known muscle tension fractions to generate each muscle’s relative moment potential for each specimen across the three conditions. The resultant summed total moment potential was then examined for differences in the flexion-extension (FE) and internal-external (IE) rotation components.

There was no significant difference in either FE or IE component for intact versus either the ACL deficient condition (FE, \( p=0.62 \), IE, \( p=0.49 \)) or arthroplasty (FE, \( p=0.99 \), IE, \( p=0.82 \)). TKA agreed more closely with the intact knee. Thus, we reject the hypothesis that a modern TKA (Journey) performs as projected by past generic results, and conclude that modern TKA effectively reconstructs the balance of the intact knee. This improves prospects for rehabilitation following TKA.
Objective: The treatment of osteonecrosis of the femoral head (ONFH) in young active patients remains a challenge. The purpose of this study was to determine and compare the clinical and radiographic results of the two different hip resurfacing systems, hemi-resurfacing and metal-on-metal total-resurfacing, in patients with ONFH.

Materials and Methods: We retrospectively reviewed 20 patients with 30 hips with ONFH who underwent hemi-resurfacing or total-resurfacing between November 2002 and February 2006. We mainly performed hemi-resurfacing for early stage ONFH, and total-resurfacing for advanced stage. Fifteen hips in 11 patients had a hemi-resurfacing component (Conserve, Wright Medical Co) with the mean age at operation of 50 years and the average follow-up of 5.5 years. Fifteen hips in 10 patients had a metal-on-metal total-resurfacing component (Birmingham hip resurfacing, Smith & Nephew Co.) with the mean age at operation of 40 years and the average follow-up of 5 years. Clinical and radiographic reviews were performed.

Results: The average postoperative JOA hip scores were 86 points in hemi-resurfacing, 96 points in total-resurfacing. The difference of pain score was a main factor to explain the difference of total JOA hip score in the two groups. Both implants were radiographically stable, but radiolucent lines around the metaphyseal stem were more frequent in total-resurfacing. In hemi-resurfacing patients, ten of 15 hips had groin pain or groin discomfort, three hips were revised to total hip arthroplasties (THA) because of femoral neck fracture, acetabular protrusio, and osteoarthritic change, respectively. On the other hand, in total-resurfacing patients, there were no revision and no groin pain.

Discussion: In the prosthetic treatment of young active patients with ONFH, it is theoretically desirable to choose an implant with conservative design in anticipation of the future revision surgery. Hemi-resurfacing hip arthroplasty is the most conservative implant for the treatment of ONFH. However, the results of hemi-resurfacing in this study have been very disappointing due to high revision rates and insufficient pain relief despite of the good implant stability. On the other hand, the pain relief and implant survivorship after total-resurfacing were superior to the results of hemi-resurfacing, although the usages of the total-resurfacing were for more advanced cases. These results suggested that total-resurfacing was a more valuable treatment option for active patients with ONFH than hemi-resurfacing.
THE INFLUENCE OF MEDIALISATION AND LATERALISATION OF THE FEMORAL HEAD ON THE FORCES ACTING ON THE HIP AFTER TOTAL HIP REPLACEMENT.

C. Manders, A.M. New and M. Taylor

Bioengineering Science Research Group, University of Southampton, Southampton, UK

During hip replacement surgery the hip centre may become offset from its natural position and it is important to investigate the effect of this on the musculoskeletal system. Johnston et al [1] found that medialisation of the hip centre reduced the hip joint moment, hip contact and abductor force using a musculoskeletal model with hip centre displacements in 10mm increments. More recently an in vivo study found that the range of displacement of the hip centre of rotation was from 4.4mm laterally to 19.1mm medially [2]. To investigate the hypothesis that medialisation of the hip centre reduces the hip contact force, a musculoskeletal model of a single gait cycle was analysed using three scenarios with the hip in the neutral position and with it displaced by 10mm medially and laterally.

The lower limb musculoskeletal model included 162 Hill type muscle units in each leg and uses a muscle recruitment criterion based on minimising the squared muscle activities, where the muscle activity is the muscle force divided by the muscle’s maximum potential force. The maximum potential force is affected by the length of the muscle unit and the muscle’s tendons each are calibrated to give the correct length in its neutral position. The same gait analysis data from one normal walking cycle was applied to each modelled scenario and the resultant hip joint moment, hip contact force and muscle forces were calculated. The abductor muscles forces were summed and the peak force at heel strike reported. The peak resultant hip moments and the peak hip contact forces at heel strike are also reported and compared between the different scenarios. The scenarios were each run twice, once with the muscle tendon lengths calibrated for the hip in the altered position and subsequently with the muscle tendon lengths maintained from the neutral hip position.

For the medialising of the femoral head, the hip contact force and the peak abductor force were reduced by 4% and 2% respectively compared the neutral position. However if the tendon lengths of the muscles were maintained from the neutral position, the medial displacement model had a 3% higher hip contact force and a 6% larger abductor force than calculated for the neutral position. Although the peak resultant hip joint moment increases with a lateral displacement by 3%, the peak abductor force and peak hip contact force have a reduced force of 3% compared to the neutral hip. Using the muscle tendon lengths calibrated for the hip in the original position produces a 3% increase in the hip contact and abductor force for the lateralised femoral head.

This study has shown that the hip contact force and abductor force depend on the calibration of the muscle’s tendon lengths. Using the model with muscles calibrated for the altered hip centre produced the hypothesised reduction in hip contact force. However, maintaining the tendon lengths from the neutral position had a significant effect the calculated forces. The hip contact and abductor forces increased in the models with the original tendon lengths and the effect was also found to be greater when the hip was displaced medially.

Accurate segmentation of bone structures is an important step in surgical planning. Patient specific 3D bone models can be reconstructed using statistical atlases with submillimeter accuracy. By iteratively projecting noisy models onto the bone atlas, we can utilize the statistical variation present in the atlas to accurately segment patient specific distal femur and proximal tibia models from the CT data.

Our statistical atlas for the knee consists of 199 male distal femur models and 71 male proximal tibia models. We performed an initial registration between the average model from the atlas and the volume space before beginning the segmentation algorithm. Intensity profiles were linearly interpolated along the direction normal to the surface of the current model. The profiles were then smoothed via a low-pass filter. A point-to-nearest peak gradient was calculated for each profile, and then weighted by a Gaussian window centered about the originating vertex. The flesh-to-bone edge locations are taken as the maximum of the weighted gradient. The detected locations were then projected onto the atlas using a subset of the available principal components (PC’s). The amount of variation is increased by projecting the edge locations onto a larger subset of PC’s. The process is repeated until 99.5% of the statistical variation is represented by the PC’s. Though our dataset is much larger, we initially performed bone segmentation on 5 male knee joints. The knee joint was considered to be the distal femur and proximal tibia. We used manually segmented models to determine ground truth. Initial results on the 5 knee joints (distal femur and proximal tibia) had a mean RMS error of 1.192 mm, with a minimum of 1.010 mm. Segmentation on the distal femur achieved a mean RMS error of 1.213 mm, and the results for the tibia had a mean RMS error of 1.264 mm.

Our results suggest that our atlas-based segmentation is capable of producing patient-specific 3D models with high accuracy, though patient-specific degeneration was often not well represented. To achieve more accurate patient-specific models, we must incorporate local deformations into the final model.
IN VIVO DETERMINATION OF THA KINEMATICS FOR SUBJECTS HAVING TWO DIFFERENT SURGICAL APPROACHES.

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Previous fluoroscopic analyses of Total Hip Arthroplasty (THA) determined that the femoral head slides within the acetabular cup, leading to separation of certain aspects of the articular geometries. Although separation has been well documented, it has not been correlated to clinical complications or a more in-depth understanding of the cause and effect. Surgical technique is one of the important clinical factors when considering THA procedures, and it is hypothesized, that it could affect the magnitude and occurrence of femoral head separation (sliding) in THAs. Hence, the objective of this study was to determine and compare in-vivo THA kinematics for subjects implanted with a THA using two different surgical approaches.

Thirty seven subjects, each implanted with one of two types of THA were analysed under in vivo, weight-bearing conditions using video fluoroscopy while performing a sit-to-stand activity. Ten subjects were implanted by Surgeon 1 using a long incision posterolateral approach (G1); while a further 10 subjects were implanted by the same surgeon using a short incision posterolateral approach (G2). The remaining 17 subjects were implanted using the anterolateral approach; 10 by Surgeon 2 (G3) and seven by Surgeon 3 (G4). All patients with excellent clinical results, without pain or functional deficits were invited to participate in the study (HHS > 90). 3D kinematics of the hip joint was determined, with the help of a previously published 2D-to-3D registration technique. From a completely seated position to the standing position, four frames of the fluoroscopy video were analysed.

Subjects in all groups experienced some degree of femoral head separation at all increments of the sit-to-stand activity that were analysed. The magnitude and frequency of separation greater than 1.0mm varied between each surgeon group, between incision types, between incision lengths and between the two types of THA that were analysed. The average maximum separation was 1.3, 1.1, 1.3 and 1.4mm for G1, G2, G3 and G4 respectively. Though there was no difference in the average maximum separation values for the 4 groups, the maximum separation varied significantly. While the maximum separation in G2 was 1.8mm, the maximum separation in G4 was 3.0mm. G1 and G3 had maximum separation values of 2.3mm and 2.4mm respectively.

This study suggests that there may be a correlation between incision lengths and surgical approach with femoral head separation in THAs. The maximum separation that was seen among all groups was a subject with a traditional long incision, while the short incision group had less incidence of separation. Results from this study may give researchers and implant developers a better understanding of kinematics around the hip joint and how they vary with respect to different surgical techniques. Further analysis is being conducted on the subjects before definitive conclusions can be made.
HIP RESURFACING ARTHROPLASTY: THE EFFECT OF ANTERIOR AND POSTERIOR NOTCHING ON FRACTURE RESISTANCE

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Surgeons performing hip resurfacing ante-vert and translate the femoral component anterior to maximize head/neck offset and reduce impingement. The anterior femoral neck is under tensile forces during gait similarly to the superior neck [6]. This study was designed to determine the risk of femoral neck fracture after anterior or posterior notching of the femoral neck.

Method: Fortyseven 4th generation synthetic femora were implanted with Birmingham Hip Resurfacing prostheses (Smith & Nephew Inc. emphis, USA). Implant preparation was performed using imageless computer navigation (VectorVision SR 1.0, BrainLAB, Germany). The virtual prosthesis was initially planned for neutral version and translated anterior, or posterior, to create the notch. The femora were fixed in a single-leg stance and tested with axial compression using a mechanical testing machine. This method enabled comparison with previously published data. The synthetic femora were prepared in 8 experimental groups: 2mm and 5mm anterior notches, 2mm and 5mm posterior notches, neutral alignment with no notching (control), 5mm superior notch, 5mm anterior notch tested with the femur in 25° flexion and 5mm posterior notch tested with the femur in 25° extension. We tested the femora flexed at 25° flexion to simulate loading as seen during stair ascent. [3] The posterior 5mm notched femoral necks were tested in extension to simulate sporting activities like running. The results were compared to the control group in neutral alignment using a one-way ANOVA:

Results: Testing Group Mean load to failure Significance
Neutral (Control) 4303.09 ± 911.04N Anterior 2mm 3926.62 ± 894.17N p=0.985
Anterior 5mm 3374.64 ± 345.65N p=0.379 Posterior 2mm 4208.09 ± 1079.81N p=1.0
Posterior 5mm 3988.07 ± 728.59N p=0.995 Superior 5mm 2423.07 ± 424.16N p=0.003
Anterior 5mm in 25° flexion 3048.11 ± 509.24N p=0.087
Posterior 5mm in 25° extension 3104.61 ± 592.67N p=0.117

Both the anterior 5mm notch tested in single-leg stance and anterior notch in flexion displayed lower compressive loads to failure (3374.64N and 3048.11N ). The mean load to failure value for the posterior 5mm notches in extension was 3104.62N compared to 4303.09N for the control group. Our data suggests that anterior and posterior 2mm notches are not statistically significantly weaker in axial compression. The anterior 5mm notches tend towards significance in axial compression (p=0.38) and bordered significance in flexion (p=0.087). The 5mm posterior notches were not significantly weakened in axial compression (p=0.995), but tended towards significance in extension (p=0.117). The 5mm superior notch group was significantly weaker with axial compression supporting previous data published (p=0.003). We are currently assessing offset and other variables that may reduce data spread.

Conclusion: We conclude that anterior and posterior 2mm notching of the femoral neck has no clinical implications, however 5mm anterior notches may lead to fracture. The fracture is more likely to occur with stair ascent rather than normal walking. Posterior 5mm notches are not likely to fracture with normal gait, but may fracture with higher impact activities that promote weight bearing in extension. Hip resurfacing is commonly performed on active patients and ultimately 5mm notching in the anterior or posterior cortices has clinically important implications.
Fracture of the distal radius is one of the most common wrist fractures that orthopedic surgeons face. Quite often an injury is too severe to be repaired by supportive measures and pin or plate fixation is the subsequent alternative. In this study we present a novel method for automated 3D analysis of distal radius utilizing statistical atlases, this method can be used to design pin or plate fixation device that accurately fit the anatomy.

A set of 120 bones (60 males and 60 females) were scanned using high resolution CT. These CT scans were then segmented and the surface models of the radius were added to the statistical atlas. Global shape differences between males and females were then identified using the statistical atlas. A set of landmarks were then calculated including the tip of the lateral styloid process and centroid of the distal plateau. These landmarks were then used to calculate the width of the distal plateau, the height of the distal plateau, overall radius length and the curvature of the distal plateau. These measurements were then compared for both males and females. Three of the measurements came statistically significant with p<0.01. Curvature of the distal plateau wasn’t found to be significant, with females having slightly higher radius of curvature than males.

This automated 3D analysis overcomes the major drawbacks of 2D x-ray measurements and manual localization methods. Thus, this analysis quantifies more accurately the anatomical differences between males and females. Statistically significant anatomical gender differences were found and quantified, which can be used for the design of trauma prosthesis that can fit normal anatomy.
“HARD TO HARD BEARING: “ACTUALITY, PERSPECTIVES, COMPLICATIONS”,
A.Palermo, G. Calafiore, M. Rossoni, R. Simonetta

The return to the use of big diameter femoral heads is now a well-established reality. The certainty of a better result is not only for young patients with an high functional demand, but also for elderly people, who need a reduction of enticement time and an increase of intrinsic

Materials optimization and “hard to hard” bearings allowed surgeons to reduce the problem of volumetric wear and to guarantee some undeniable advantages such as:
- better articular stability, thanks to the off-set restore
- better range of motion
- reduction of dislocation risk

Increasing the femoral head diameter means increasing the off-set therefore the lever arm of the gluteus medius which is a great articular stabilizer. With the old metal to polyethylene and ceramic to polyethylene bearings, the bigger contact surface between the head and the cotyle interior certainly increased the volumetric wear in the past. The introduction of bearings at “low friction coefficient” ceramic-to-ceramic and metal-to-metal solved this problem and the undeniable improvement of the polyethylene preparation made this material to be considered safe even with big diameter heads. All articular stability parameters, in primis for the off-set, can be improved by the use of those solutions which are all efficient and able to give the surgeon the right mean to solve every single case.

The eventuality to break ceramic heads is reported in literature and has fortunately reference to a low percentage, about 1.5% (“Biolox 28 mm ceramic-ceramic THR: 1.5% fractures 7 years f.u.” Toni, Alt.Bearings, NYC, 2002), but it maybe limits this kind of choice in cases of hip dysplasia, in which a bigger acetabulum uprightness increases the percentage of mistake in placing the cotyle. Nowadays, the diameter of the available heads is progressively increasing with the cotyle diameter (32 , 36), so ceramic-ceramic is anyway an excellent solution for all other fatigued coxofemural articulations, above all if they are still eumorphic, and for female patients in which a worst bone quality reduces the choice of metal-metal.

The metal-metal bearing finds instead a great indication in all patients, above all male patients with a good bone quality with high functional demand. The only reasons to go back preferring the metal-metal bearing are the reduction of the average age of the prosthesized patient and the increasing performance need. New techniques of superficial finish of the chrome-cobalt allowed surgeons to optimize the clearance, the self-smoothing ability in case of “streaks” of third body.

Tests drawn in gate analysis demonstrated a reduced detachment between the two prosthesis components when the metal-metal operated patient makes the step, not only in favour of the bearing, but also of the choice of big diameters (“Metal on metal and distraction: an in vivo comparison.” Komistec et al; JBJS; October 2002). Moreover, other indications in literature show that there is no direct correlation between the cancer development and the metal-metal bearing prosthesis implant (Visuri, COOR 1996) (“The risk of cancer following total hip or knee arthroplasty” Tharani et al., JBJS May 2001), and even that there were no cobalt toxic serum levels able to justify cardio-pneumatie (Brodner, JBJS 1997).

Independently by the materials choice, the bearing with big diameter heads undeniably reduces dislocation risk and accelerates the post-operative recovery even in old patients surgically treated for fracture.

The larger distance a big diameter head has to cover in order to come out of the acetabular cavity (Jump distance) certainly reduces the number of dislocation cases. (“Large versus small femoral heads in metal on metal total hip arthroplasty” –Cucler J.M. et al., JoA, Vol 19, num 8, suppl. 3., 2004) (“Effect of femoral head diameter and operative approach on risk of dislocation after primary total hip arthroplasty” Berry DJ et al., JBJS Am. 2005 Nov; 87(11):2456-63).

All those reasons pushed us to believe in “hard to hard” bearings with big diameter, whose results could not be more satisfying. Nevertheless, there are some complications which can make us think, such as cases of pseudocancer for metal-metal bearing and the squeaking in the ceramic-ceramic bearing. The introduction of last generation polyethylene could bring the golden standard near the ceramic-polyethylene again.
Orthographic radiography, a revelation at its inception, has been the orthopaedic standard for a century. It has facilitated osteology and empowered arthroplasty like no other parallel technology. While many new imaging modalities – nuclear scans, computerized axial tomography, magnetic resonance imaging, etc. – have advanced the art even further, plain X-rays, quite frankly, remain the standard for identifying patient pathology and evaluating surgical intervention. The enlightened scrutiny of properly obtained and successfully reproduced radiographic images still yields far more information in the daily practice of orthopaedics than its more sophisticated and expensive derivatives. A detailed review of readily available diagnostic information is intended to rejuvenate/resuscitate our most valuable ally in the evolving struggle against arthritic disease.
A PROSPECTIVE DUOCENTER STUDY ON THE CLINICAL AND
RADIOLOGICAL OUTCOME OF THE MULTIGEN PLUS TOTAL KNEE
SYSTEM WITH A BIOLOXÒ DELTA CERAMIC FEMORAL COMPONENT
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The objective of this prospective duo-center study was to evaluate the clinical and
radiological outcome of the unconstrained Multigen Plus total knee system (Lima Lto,
San Daniele, Italy) with the new BIOLOXÒ Delta ceramic femoral component.

40 patients underwent cemented total knee arthroplasty in two university
hospitals. Clinical evaluations were undertaken preoperatively and at 3 as well as 12
months postoperatively using the HSS-Score, WOMAC-Score and SF-36-Score. The
radiological investigations included ant-post. radiographs (whole leg in two leg stance
and lateral view of the knee) and patella tangential radiographs (Merchant view).

During 12 months follow-up three patients underwent revision surgery. One
patient had to be revised due to infection after postoperative opening of the knee joint
due to direct trauma. One patient sustained an osteosynthetic procedure due to
periprosthetic fracture after trauma. In one patient a retropatellar replacement was
inserted one year postoperatively. Implant related complications were not found. The
mean preoperative HSS-Score amounted to 57.8±11.7 points. At 3 and 12 month
follow-up the mean HSS-Score was 76.0±12.3 and 83.3±11.9 points respectively.
Therefore HSS, as well as WOMAC and SF-36 Score improved significantly from
preoperatively to both postoperative evaluations (Wilcoxon-Test p<0.002). Radiolucent
lines around the femoral ceramic component were found in six cases.

However, subsequent long-term studies must be carried out in order to prove
the good early clinical results and to clarify if progression of radiolucent lines may
influence the clinical outcome of the presented newly ceramic total knee system.
The three distinct phases of design and development of total knee replacement (TKR) were: (1) 1969-1985, (2) 1986-2000 and (3) 2000 to today and beyond.

Hinge designs and early condylar designs highlight the first major period of TKR development from 1969 to 1985. These designs included but were not limited to the Waldius, Shiers, and GUEPAR hinges, Gunston’s Polycentric Knee in 1971, Freeman’s ICLH Knee in 1972, Coventry’s Geomedic Knee in 1972, St. George’s Sled Prosthesis in 1971, Marmor’s Modular Uni in 1971, Townley’s Condylar Design in 1972, Walker and Ranawat’s Duocondylar in 1971, Waugh’s UCI Knee in 1976, Eftekar’s Metal Backing in 1978, Murray and Shaw’s Metal Backed Variable Axis Knee in 1978, Insall and Burstein’s IB-1 Knee in 1978, the Kinematics in 1978, and finally Walker, Ranawat and Insall’s Total Condylar in 1978.

The Total Condylar Knee, developed by Walker, Ranawat, and Insall between 1974 and 1978, has been the benchmark for all designs through the 20th century. My personal experience of cemented TKR from 1974-2009 has shown a survivorship of 89%-98% at 15-20 years. Similar data has been presented in several 10+ year follow-up studies.

The next major phase of development gave birth to semi-constrained TKR, cruciate saving and substituting PS designs, improved instrumentation and improved cemented fixation. Other guiding principles involved improving alignment, managing soft-tissue balance for varus-valgus deformity, improving kinematics and producing superior polyethylene for reduced wear and oxidation. The advent of rotating platform mobile bearing knees with multiple sizes marked the most recent major advancement in TKR design.

With more total knee replacements being performed on younger, more active patients, improved design, better fixation (non-cemented), and more durable articulation are needed. The new standard for ROM will be 125 degrees. Non-cemented fixation, improved poly, such as E-poly, and the rotating platform design will play a major role in increasing the longevity of TKR to over 25 years.
THE LEGACY OF JOHN N. INSALL
G.R. Scuderi

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John N. Insall accomplished unparalleled success as an orthopedic surgeon, implant designer, and teacher. Over a span of 4 decades he was a pioneer in the field of knee surgery and was instrumental in evolving total knee arthroplasty to its current state of excellence. His legacy in total knee implant design began with the Duocondylar and Duopatellar prosthesis; was revolutionary with the implantation of the first Total Condylar Prosthesis - the first modern prosthesis; followed by posterior cruciate ligament substitution with the Insall – Burstein Posterior Stabilized Prosthesis; and ultimately with the Legacy Posterior Stabilized High Flexion Prosthesis – a fixed and mobile bearing high performance implant. Recognizing the importance of surgical technique with any implant design, Insall simultaneously described the surgical technique of ligament releases for restoring axial alignment and balancing the flexion and extension gaps. Over time his innovations have been embraced by the majority of surgeons and have become the foundation of what we do today. During more than 40 years of clinical practice, John N. Insall was an unselfish educator. He shared his clinical experiences with the medical community by publishing, along with his students and associates, an exhaustive array of articles and books on various afflictions of the knee. Recognized by his contemporaries as a leader in the field of total knee arthroplasty, he was elected president of the Knee Society in 1987. For the entire orthopedic community he continued to work laboriously, sharing his experiences with his fellows and colleagues until his death in 2000. The life of John N. Insall will be remembered in perpetuity for his unparalleled influence on knee surgery.
Sir John Charnley unquestionably was the pioneer of modern joint arthroplasty. He was also an innovator in many other areas of orthopedics, including fracture care and arthrodesis, but this tribute will focus on his contributions to arthroplasty.

Charnley pioneered the use of methyl methacrylate cement and in so doing provided the first reliable means of fixing implants to bone. For the first time, this provided arthritis patients with reproducible long-term, reliable pain relief from advanced joint arthritis. Charnley also pioneered the use of a novel bearing surface, high molecular weight polyethylene. In so doing, he pioneered resurfacing of both sides of a joint with a low-friction, low-wear bearing. This provided the potential for excellent pain relief and also durable function of a hip arthroplasty. Charnley understood the importance of reproducing joint mechanics and kinematics, and the arthroplasties he designed fully reproduced leg length and hip offset, and therefore the mechanics of the hip.

Finally, Charnley understood that technology is only a great value when it can be transferred effectively to many surgeons around the world. He created a carefully constructed educational structure to teaching the methodology in a way that would allow surgeons to practice this procedure successfully in other centers. Charnley understood the importance of minimizing complications for a procedure to be widely adopted and successful.

It is no exaggeration to state that Charnley’s contributions have helped tens of millions of patients worldwide who otherwise would have been permanently crippled by arthritis. Today’s further advances in joint arthroplasty are all dependent on the foundations of joint arthroplasty pioneered by Sir John Charnley.
TRIBUTE TO HAP PAUL
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Hap Paul was a unique individual. It is appropriate that this award should go a unique paper presented at this year’s ISTA. The name “Hap” comes from his initials Howard A. Paul. He was an outstanding veterinarian, but he was also much more than that. He had an insatiable curiosity combined with a quick mind and a surgeon’s practicality. His first love was research. After graduating from high school in Connecticut, he went to Notre Dame as a swimmer. He graduated with a degree in Microbiology and a strong desire to “cure cancer”. Acting on his dreams, as he always did, he decided to go to Paris to work with one of the pioneers of Interferon research. Never mind that he didn’t have a job and did not know a word of French. Of course he got the job and learned French playing rugby (hence his awful accent and colorful vocabulary). The funding ran out for the Interferon research, but he somehow got a shot at a spot in the veterinary school in Paris. He got married and finished his veterinary training. The veterinary thing worked out, but the marriage didn’t. He returned to the US after 9 years living in France, to attend the UC Davis School of Veterinary Science as a surgical resident in the small animal area. He met his wife, Dr. Wendy Shelton there…but that is another story.

I met Hap when I was a new attending orthopaedic surgeon at UC Davis and looking to do some animal modeling of hip replacement revision techniques. He was an imposing figure: six feet four, big curly afro and wire glasses. He dressed like a Frenchman, wore big clogs and carried a purse. Needless to say I was intimidated initially. But, he had great *joie de vivre* and lived up to his name… he was almost always happy.

Hip replacement in dogs began in the 1970’s, but was nearly abandoned by the early 1980’s because of infections and “luxations” (dislocations). In order to develop an animal model we had to develop instruments and techniques that incorporated “third generation” cementing techniques. This we did, but Hap took these instruments and began using them clinically on working dogs. He developed quite a reputation for resurrecting hip replacements for dogs in the US and internationally. Hap and I went on to develop dog models for CT-based custom implants and later surgical robotics (eventually leading to the development of Robodoc). Despite our academic interests, both Hap and I went into private practice in the mid 1980’s…separately, of course (he as a veterinary orthopaedic surgeon and I specialized in hip and knee replacements for humans). Our research in surgical robotics took off when we landed a huge grant from IBM. But then the sky fell in when we learned that Hap had developed lymphoma. After surgery, radiation and chemotherapy, he was in remission, but temporarily couldn’t perform surgery due to a peripheral neuropathy attributed to Vincristine. So Hap went to the lab at UC Davis to work directly with the robotics team. He was a slave driver…but a pleasant one. Certainly the basic research behind Robodoc could not have been done without Hap getting lymphoma.

Over 5 years (1986-91) we both had a ball working with some of the best minds in robotics and imaging research. We presented our research on CT-based customs and robotics at many international venues, and Hap made many friends…some are in the audience today. He was one of the founders of this organization (ISTA). Hap returned to veterinary practice when he could finally work with his hands again…but this was not for long. Soon our research lead to the founding of Integrated Surgical Services (ISS) in 1991, the makers of Robodoc. Hap agreed to leave his practice to lead the company and I stayed in clinical practice to develop and utilize the device on patients. In 1992, we shocked the world by being the first to use an active robot in human surgery. It looked like the dawning of a new age. (I still believe it is, but it has been a very slow dawn).

For Hap, the joy was short-lived. He developed leukemia as a complication of his prior chemotherapy. He died while recovering from a bone marrow transplant on Feb. 10, 1993 at the young age of 44. During his short life he contributed tremendously to the benefit of others by his research and development work. But mostly he inspired others to excel in their endeavors. He was a wonderful guy. And we are all pleased to honor him with the presentation of the Hap Paul Award at each year’s meeting of ISTA.
IN VITRO IMAGING OF LIVING CELLS WITH ULTRASOUND INTENSITY MICROSCOPE

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Introduction: Acoustic microscopy for medicine and biology has been developed for more than twenty years at Tohoku University [1-8]. Application of acoustic microscopy in medicine and biology has three major features and objectives. First, it is useful for intra-operative pathological examination because staining is not required. Second, it provides basic acoustic properties to assess the origin of lower frequency ultrasonic images. Third, it provides information on biomechanical properties at a microscopic level because ultrasound has close correlation with mechanical properties of the tissues. This paper describes the preliminary results obtained using 300 MHz ultrasound intensity microscopy for in vitro characterization of rat synovial cell cultures. The novelty of the approach lies in the fact that it allows remote, non-contact and disturbance-free imaging of cultured synovial cells and the changes in the cells' properties due to external stimulants such as transforming growth factor beta-1 (TGFbeta1).

Materials and Methods: Ultrasound intensity microscope: An electric impulse was generated by a high speed switching semiconductor. The electric pulse was input to a transducer with sapphire rod as an acoustic lens and with the central frequency of 300 MHz. The reflections from the tissue was received by the transducer and were introduced into a Windows-based PC (Pentium D, 3.0 GHz, 2GB RAM, 250GB HDD) via a digital oscilloscope (Tektronix TDS7154B, Beaverton, USA). The frequency range was 1GHz, and the sampling rate was 20 GS/s. Four values of the time taken for a pulse response at the same point were averaged in order to reduce random noise. The transducer was mounted on an X-Y stage with a microcomputer board that was driven by the PC through RS232C. The Both X-scan and Y-scan were driven by linear servo motors. The ultrasound propagates through the thin specimen such as cultured cells and reflects at the interface between the specimen and substrate. A two-dimensional distribution of the ultrasound intensity, which is closely related to the mechanical properties, was visualized with 200 by 200 pixels.

Tissue preparation: The synovial membrane was obtained from non-operated male rats weighing from 380 to 400 g through medial para-patellar incision. The tissue was diluted and loosened 0.15% DispaseII (Boehringer, Mannheim) in DMEM for 2 hours at 37 C°. Then centrifuged at 400 g for 5 min and discard the supernatant. The cells were plated in 75 mm² dish (Falcon) with Dulbecco’s modified Eagle’s medium (DMEM, GIBCO Laboratories) containing 10% fetal bovine serum (SIGMA Chemical Co.) at 37 C° in a CO2 incubator. To determine changes of intensity, the cells were treated with 1 ng/ml of human recombinant TGF-β1 (hTGF-β1, R&D Systems, Inc.) for 1 and 3 days after reaching confluent. The non-treated cells was harvested at 3 days after reaching confluent and defined as control. Randomized four points at each dish were measured and averaged data was defined as the representative value of each dish. The cells used for experiments were at the third passage.

Signal processing: The reflection from the tissue area contains two components. One is from the tissue surface and another from the interface between the tissue and the substrate (phosphate buffered saline). Frequency domain analysis of the reflection enables the separation
of these two components and the calculation of the tissue thickness and intensity by Fourier-transforming the waveform [9].

**Image analysis:** Randomized point regions were determined using ultrasound intensity microscopic images. This was done by employing commercially available image analysis software (PhotoShop CS2, Adobe Systems Inc.). Ultrasound intensity microscopic images with a gradation color scale were also produced for clear visualization of the ultrasound intensity variations.

**Statistics:** Statistical analysis among groups was performed using one factor analysis of variance. Data were expressed as mean ± standard deviation. A value of P < 0.05 was accepted as statistically significant.

**Results:** The ultrasound intensity microscope can clearly visualize cells. The high intensity variations area of the reflected ultrasound energy at the central part of the cell corresponded to the nucleus and the high intensity area at the peripheral zone corresponded to the cytoskeleton mainly consisting of actin filaments. The intensity of the reflected ultrasound energy at the peripheral zone was significantly increased after stimulation with hTGF-b1.

**References:**
At ten years, alumina ceramic bearings are functioning well with low complication rates and a fewer number of revisions than the control cohort.

Alumina ceramic bearings have proven superior wear resistance, lubrication, and scratch resistance, without carrying the risk of metal ion release. In 1996 a U.S. IDE clinical trial was initiated utilizing newly improved alumina ceramic materials and implant design. The purpose of this multi-center, prospective, randomized study is to prove comparable safety and efficacy of alumina-alumina ceramic to a control cobalt chrome-polyethylene bearing.

Four hundred fifty two patients (475 hips) are followed in this study. Subjects include ceramic on ceramic, with either porous coated cup or arc deposited cup, or control group with metal on polyethylene with porous coated cup. Average age of subject at time of surgery was 53 years with 82% diagnosis of OA. The average Harris Hip Score was 96 and 94% of hips had little to no pain. Kaplan-Maier survivorship at 10 years, component revision for any reason, was 95.9% for ceramic bearings compared to 91.3% for metal on polyethylene control. There have been nine hips requiring revision of one or both components for any reason.

Data was recently collected on the subjects that participated in either the IDE or Continued Access arms of the ABC® and Trident® study. Data collection included revisions, complications, and noise. Out of 930 hips (848 patients) there were nine incidences of squeaking noise reported, no wear/osteolysis issues, and only two insert fractures (0.2%).

At ten years ceramic bearings show no wear, inconsequential lysis, minimal breakage, and occasion noise. Clinically, alumina ceramic bearings perform as well as the metal-on-polyethylene, with fewer revisions and less osteolysis, suggesting that they are a safe, viable option for younger, more active patients.
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TWO DIFFERENTS APPROACHES IN THR: A GAIT ANALYSIS STUDY
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The choice of surgical technique for total hip arthroplasty (THA) can affect time and postoperative rehabilitation procedures. The aim of this prospective blinded cohort study is to determine significant differences in gait parameters in the short term between those patients who have experienced THA using a limited incision anterolateral intermuscular (MIS) approach compared with those who have experienced traditional lateral transmuscular (LTM) approach.

Thirty patients were enrolled in this study, 15 of who received the MIS technique and 15 the LTM approach. A single surgeon performed all the operations using short hip stem implants with 36mm femoral head size and all patients received a standard postoperative rehabilitation protocol. Patients, physiotherapists, and assessors were blinded to the incision used. Gait analysis was performed 30 day after surgery, when patients were able to ambulate without crutches.

Minimal differences in temporospatial parameters were shown between the MIS and LTM groups, whereas significant differences (p<0.05) in kinematics (hip range of motion in sagittal, frontal and transverse planes), kinetics (hip flexion/extension and abduction/adduction moments) and electromiography parameters (gluteus medius activation pattern and degree of activity) between two groups.

This study demonstrates functional benefits of the minimally invasive incision over the standard lateral transmuscular approach in terms of walking ability 30 days postoperatively.
CERAMIC-ON-CERAMIC alumina bearings (ALX) have demonstrated low wear with minimal biological consequences for almost four decades. An alumina-zirconia composite (BIOLOX-DELTATM) was introduced in 2000 as an alternative ceramic. This contains well-distributed zirconia grains that can undergo some surface phase transformations from tetragonal to monoclinic. We analyzed 5 cases revised at 1-7 years to compare to our simulator wear studies. For the retrieved DELTA bearings, two important questions were (a) how much tetragonal to monoclinic transformation was there in the zirconia phase and (b) how much did the articular surfaces roughen, either as a result of this transformation or from formation of stripe wear zones?

The retrieval cases were photographed and logged with respect to clinical and revision details. The DELTA balls varied from 22mm to 36mm diameters. These had been mated with liner inserts varying by UHMWPE, BIOLOX-FORTE and BIOLOX-DELTA materials. Bearing features were analyzed for roughness by white-light interferometry, for wear by SEM, for dimensions by CMM and for transfer layers by EDS technique. Surface transformations on DELTA retrievals were mapped by XRD. The four combinations of 36mm diameter BIOLOX-FORTE and BIOLOX-DELTA were studied in a hip simulator, which was run in ‘severe’ micro-separation test mode to 5 million cycles. Wear rates, wear stripes, bearing roughness and wear debris were compared to the retrieval data.

In two DELTA ball cases, there were conspicuous impingement signs, stripe wear and black metallic smears. It is to be noted that the metal transfer sites (EDS) appeared to be from the revision procedures. The retrieved balls run with alumina liners showed monoclinic phase peaking at 32% on the particular surface and internal bore. On the fracture surface of case 1, the monoclinic content had increased to 40%. Various surface roughness indices were assessed on the bearings. The polished articular surfaces averaged roughness (Sa) of the order 3 nm, representing extremely smooth surfaces. The main wear zone was only marginally rougher (5 nm). In contrast the stripe wear zones had roughness of the order 55–140 nm.

In the laboratory, the DELTA bearings provided a 3-6 fold wear reduction compared to FORTE controls. Roughness of stripes increased to maximum 113nm on controls. Roughness of wear stripes showed FORTE with the highest and DELTA with the lowest values. DELTA bearings also revealed much milder wear by SEM imaging. Phase transformations showed peaks at < 30% for both main wear zone and stripe wear sites. It is hypothesized that the concentration of monoclinic phase reached a certain level due to compression contraint imposed by the alumina matrix. With implant wear, additional tetragonal grains of zirconia are exposed and these will also transform to tetragonal. This consistency between laboratory and retrieval studies confirmed the stable nature of the bearings. The BIOLOX-DELTA combination provides optimal potential for a clinically relevant reduction in stripe wear.
Although resurfacing hip replacement (RHR) is associated with a more demanding patient cohort, it has achieved survivorship approaching that of total hip replacement. Occasional failures from femoral neck fracture, or migration and loosening of the femoral head prosthesis have been observed, the causes of which are multifactorial, but predominately biomechanical in nature. Current surgical technique recommends valgus implant orientation and reduction of the femoral offset, reducing joint contact force and the femoral neck fracture risk. Radiographic changes including femoral neck narrowing and ‘pedestal lines’ around the implant stem are present in well performing hips, but more common in failing joints indicating that loosening may involve remodelling. The importance of prosthesis positioning on the biomechanics of the resurfaced joint was investigated using finite element analysis (FEA).

Seven FE models were generated from a CT scan of a male patient: the femur in its intact state, and the resurfaced femur with either a 50mm or 52mm prosthesis head in (i) neutral orientation, (ii) 10° of relative varus or (iii) 10° of relative valgus tilt. The fracture risk during trauma was investigated for stumbling and a sideways fall onto the greater trochanter, by calculating the volume of yielding bone. Remodelling was quantified for normal gait, as the percentage volume of head and neck bone with over 75% post-operative change in strain energy density for an older patient, and 50% for a younger patient.

Resurfacing with the smaller, 50mm prosthesis reduced the femoral offset by 3.0mm, 4.3mm and 5.1mm in varus, neutral and valgus orientations. When the 52mm head was used, the natural joint centre could be recreated regardless of orientation, without notching the femoral neck. The 50mm head reduced the volume of yielding femoral neck bone relative to the intact femur in a linear correlation with femoral offset. When the natural femoral offset was recreated with the 52mm prosthesis, the predicted neck fracture load in stumbling was decreased by 9% and 20% in neutral and varus orientations, but remained in line with the intact bone when implanted with valgus orientation. This agrees with clinical experience and justifies currently recommended techniques. In oblique falling, the neck fracture load was again improved slightly when the femoral offset was reduced, and never fell below 97% of the natural case for the larger implant in all orientations.

Predicted patterns of remodelling stimulus were consistent with radiographic clinical evidence. Stress shielding increased slightly from varus to valgus orientation, but was restricted to the superior femoral head in the older patient. Bone densification around the stem was predicted, indicating load transfer. Stress shielding only extended into the femoral neck in the young patient and where the femoral offset was reduced with the 50mm prosthesis. The increase in remodelling correlated with valgus orientation, or reduced femoral offset. The trend would become more marked if this were to reduce the joint contact force, but there was no such correlation for the 52mm prosthesis, when the natural femoral offset was recreated. Only in extreme cases would remodelling alone be sufficient to cause visible femoral neck narrowing, i.e. patients with a high metabolism and considerably reduced femoral offset, implying that other factors including damage from surgery or impingement, inflammatory response or retinacular blood supply interruption may also be involved in femoral neck adaptation.

The results of this FEA biomechanical study justify current surgical techniques, indicating improved femoral neck fracture strength in stumbling with valgus position. Fracture risk under oblique falling was less sensitive to resurfacing. Furthermore, the results imply that reduced femoral offset could be linked to narrowing of the femoral neck; however the effects of positioning alone on bone remodelling may be insufficient to account for this. The study suggests that surgical technique should attempt to recreate the natural head centre, but still aim primarily for valgus positioning of the prosthesis, to reduce the femoral neck fracture risk.
THE QUEAKING HIP: AN UPDATE
Jonathan Garnio

Squeaking has become a more common problem following hard on hard bearings in total hip replacements. Although most squeaking is occasional and not concerning to either patient or health care practitioner, some reports of squeaking indicate high percentages (7% or higher) that can be constant and quite concerning. Much work has been done in this area, and although the exact mechanism is not yet understood, most of the data suggests a particular hip replacement system (metal alloy, taper design, cup design) significantly elevates to quantity and quality of the squeaking problem to concerning levels. Those specific details are described in depth along with future studies to improve our understanding in the nature of this acoustical phenomenon.
Total knee arthroplasty (TKA) provides relatively pain-free function for patients with end-stage arthritis. However, return to recreational and athletic activities is often restricted based on the potential for long-term wear and damage to the prosthetic components. Advice regarding safe and unsafe activities is typically based on the individual surgeon’s subjective bias. We measured knee forces in vivo during downhill skiing to develop a more scientific rationale for advice on post-TKA activities.

A TKA patient with the tibial tray instrumented to measure tibial forces was studied at two years postoperatively. Tibial forces were measured for the various phases of downhill skiing on slopes ranging in difficulty from green to black.

Walking on skis to get to the ski lift generated peak forces of $2.1 \pm 0.20 \times BW$ (times body weight), cruising on gentle slopes $1.5 \pm 0.22 \times BW$, skating on a flat slope $3.9 \pm 0.50 \times BW$, snowplowing $1.7 \pm 0.20 \times BW$, and coming to a stop $3 \pm 0.12 \times BW$. Carving on steeper slopes generated substantially higher forces: blue slopes (range $6^\circ$ to $10^\circ$), $4.4 \pm 0.18 \times BW$; black slopes (range $15^\circ$ to $20^\circ$), $4.9 \pm 0.57 \times BW$. These forces were compared to peak forces generated by the same patient during level walking: $2.6 \pm 0.4 \times BW$, stationary biking $1.3 \pm 0.7 \times BW$, stair climbing $3.1 \pm 0.31 \times BW$, and jogging $4.3 \pm 0.8 \times BW$.

The forces generated on the knee during recreational skiing vary with activity and level of difficulty. Snowplowing and cruising on gentle slopes generated lower forces than level walking (comparable to stationary biking). Stopping and skating generated forces comparable to stair climbing. Carving on steeper slopes (blues and blacks) generated forces as high as those seen during jogging. This study provides quantitative results to assist the surgeon in advising the patient regarding postoperative exercise.
DOES IMPLANT DESIGN AFFECT KNEE FLEXION? A SIMULTANEOUS BILATERAL TKA RANDOMIZED CONTROLLED TRIAL
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INTRODUCTION: Many orthopaedic device companies now offer a high flexion (HF) choice within their knee Arthroplasty portfolios. Early published results are mixed between standard (STD) and HF knee devices despite claims of increased flexion with the HF offerings. The purpose of this randomized, controlled, simultaneous, bilateral study was to compare two coronally conforming rotating platform devices to determine if flexion differences were attributed to implant design.

METHODS: Ninety-three subjects underwent simultaneous bilateral TKA across 8 centers. The HF device was randomly assigned to one side and the contralateral leg received the STD device. Average age was 61 years, 99% were diagnosed with osteoarthritis, 66% were females, average BMI was 32 and range of motion was measured by subjective expectations versus satisfaction.

RESULTS: The HF design had statistically better single leg active flexion (SLAF) 12 months after surgery compared to the STD. Consistent with Gupta et.al, in a subgroup with pre-op flexion <120 degrees in both knees, the HF device was statistically superior in passive flexion, ROM, and SLAF by between 1.8 and 4.5 degrees at 6 months, 12 months, and longitudinally over all post-operative intervals using raw degrees, improvement from pre-op, and adjusting for potentially confounding variables. 57% of subjects preferred their HF knee 6 months postoperatively, although there was no difference in preference at 12 months.

DISCUSSION: The simultaneous bilateral design of this study necessitates that subjects act as their own control eliminating most confounding variables. Gains in postoperative flexion, although small, were superior in the HF TKA group and were greater in those subjects with less than 120 degrees of preoperative flexion, suggesting the ideal candidate for a HF TKA is one with lesser preoperative flexion.
IN VIVO ASSESSMENT OF HIP KINEMATICS DURING FOUR ACTIVITIES
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Previous in vivo studies pertaining to THA performance have focused on the analysis of gait. Unfortunately, higher demand activities have not yet been analyzed. Therefore, the objective of the present study was to determine the in vivo kinematics for THA patients, using fluoroscopy, while they performed four higher demand activities.

The 3D in vivo kinematics of 10 THA patients were analyzed during the following activities: pivoting (PI), tying a shoe (SHOE), sitting down (SDOWN) and standing up (SUP) with and without the aid of handrails. Patients were matched for age, height, weight, body mass index, diagnosis and femoral head diameter to control for confounding variables possibly having influence on the hip performance and kinematics of the various activities.

The largest amount, incidence and variation of separation (femoral head sliding in the acetabular cup) were achieved during the PI with 1.5mm (SD 1.1) and 9 of 10 (90%) subjects experiencing separation. For the SHOE, SDOWN and SUP activities the average separation values were 1.1, 1.2 and 0.7mm, respectively. Femoral head separation was observed in 8 of 10 subjects (80%) during SHOE, in 9 (90%) during SDOWN, and in only one of 6 (60%) during SUP.

In this present study, subjects demonstrated hip separation during the high demand subjects, which could be a concern because these same activities are subjected to higher bearing surface forces. Also, the presence of hip separation leads to reduced contact area between the femoral head and the acetabular cup, possibly leading to higher contact stresses.
LONG TERM DURABILITY IN DEEP FLEXION KNEE WITH BI-SURFACE KNEE ARTHROPLASTY

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In Far East, including Japan and the Middle East, daily activities are frequently carried out on the floor. Deep flexion of the knee joint is therefore very important in these societies. Some patients who underwent total knee arthroplasty (TKA) in these countries often perform deep flexion activity, such as squatting, cross-leg sitting and kneeling. However it is still unknown that deep flexion activity affects long term durability after TKA. The purpose of this study was to examine the correlation between deep flexion and long term durability.

Between December 1989 and May 1997, 507 total knee arthroplasties were carried out in 371 patients using the Bi-Surface Knee System (Japan Medical Material, Osaka, Japan) at two institutions and routine rehabilitation program continued for one to two months after TKA. One patient who underwent simultaneous bilateral TKA was excluded because of pulmonary embolism within one month. The other 505 knees (370 patients) were divided into two groups according to the range of flexion after our routine rehabilitation program; one group (Group A: 207 knees) consisted of more than 135 degrees flexion knees and the other group (Group B: 298 knees) consists of less than 135 degrees flexion knees. Patients whose follow-up period was less than 10 years were excluded from this clinical evaluation. Range of flexion was measured preoperatively, at the time after routine rehabilitation program, and at the latest follow-up. Knee function was evaluated on the basis of Knee Society knee score and functional score preoperatively and at the latest follow-up. Kaplan-Meier survivorship analysis was performed with revision for any operation as the end point.

In Group A, the mean preoperative range of flexion was 133.0±16.3 degrees, and at the time after routine rehabilitation program, this improved to 139.7±5.1 degrees. This angle maintained to 136.2±14.3 at the latest follow-up. In Group B, the mean preoperative range of flexion was 111.6±20.4 degrees, and at the time after routine rehabilitation program, this improved to 114.5±13.6 degrees. This angle maintained to 118.2±17.8 at the latest follow-up. The Knee Society knee score and functional score was improved from 43.0±16.9 points and 39.0±20.2 points preoperatively to 95.1±5.8 points and 51.8±21.2 points at the latest follow-up, respectively in Group A. The Knee Society knee score and functional score was improved from 37.1±16.7 points and 31.9±18.4 points preoperatively to 92.5±8.7 points and 53.1±26.1 points at the latest follow-up, respectively in Group B. Kaplan-Meier survivorship at 10-year was 95.5% in Group A and 96.2% in Group B with any operation as the end point. The survivorship between Group A and Group B was not statistically significant.

Good range of flexion was maintained and Knee society score was excellent after a long time follow-up for the patients who achieved deep flexion after TKA. Deep flexion was proved not to affect long term durability in this Bi-Surface Knee System.
FEMORAL COMPONENT
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Introduction: Although use of modular femoral components in revision hip arthroplasty is widely accepted, many still question the need for modular versatility in primary THA. The purpose of our study was to examine in a large cohort the percentage of hips in which femoral component version was changed to optimize stability or avoid prosthetic impingement of the THA construct. We hypothesized that the percentage of hips needing version change in routine primary THA would be low.

Methods: This prospective study analyzed 1000 consecutive primary THAs using a modular S-ROM (DePuy) stem performed by 3 surgeons at 3 institutions all via a posterior approach. Mean patient age at surgery was 57.5 years; 51.6% were male. The difference in version between the femoral sleeve placed anatomically and the femoral stem was recorded intra-operatively.

Results: Femoral component version was changed in 47.9% of hips. Logistic regression analysis showed no correlation between the likelihood of changing stem version and patient age (p=0.87), gender (p=0.23), diagnosis (p=0.54), or surgeon (p=0.27). 10 hips (1%) experienced early dislocation (within 3 months post-op). With the numbers available, there was a slight trend of lower dislocation rate in hips where stem version was changed (0.6%) versus those in which it was not (1.5%, p=0.16, chi squared).

Conclusion: The incidence of femoral version change in routine primary THA was much higher than expected. It was difficult to predict the need to alter version based on clinical variables including diagnosis. Thus, we conclude it may be advantageous to routinely use a stem that allows variable version as it is not possible to preoperatively determine when changing version will be required. In addition, we surmise our low dislocation rate compared to historical controls of THA performed using a posterior approach was aided by the ability to adjust version in almost half of our patients.
Implant positioning is a critical factor in assuring the primary stability of cementless Total Hip Replacements (THR). Although it is under the direct control of surgeons, finding the optimal implant position and achieving a perfect fit remain a challenge even with the advent of computer navigation. Placement of the femoral stem in an excessive ante/retroversion or varus/valgus orientation can be detrimental to the performance of THR. To determine the effect of such malalignment, finite element (FE) computer modelling is often used. However, this can be time consuming since FE meshes must be repeatedly generated and solved each time for a range of defined implant positions. In the present study, a mesh morphing technique is developed for the automatic generation of FE models of the implanted femur; in this way, many implant orientations can be investigated in a single analysis.

An average femur geometry generated from a CT scan population of 13 male and 8 female patients aged between 43 and 84 years was considered. The femur was virtually implanted with the Furlong HAC titanium alloy stem (JRI Ltd, Sheffield, UK) and placed in the medullary canal in a baseline neutral nominal position. The head of the femur was then removed and both femur and implant volumes were joined together to form a single piece that was exported into ANSYS11 ICEM CFD (ANSYS Inc., 2008) for meshing. To adequately replicate implant ante/retroversion, varus/valgus or anterior/posterior orientations, the rigid body displacement of the implant was controlled by three rotations with respect to a local coordinate system. One hundred different implant positions were analysed and the quality of the morphed meshes analysed for consistency.

To check the morphed meshes, corresponding models were generated individually by re-positioning the implant in the femur. Selected models were solved to predict the strain distribution in the bone and the bone-implant relative micromovements under joint and muscle loading. A good agreement was found for bone strains and implant micromotions between the morphed models and their individually run counterparts. In the postprocessing stage further metrics were analysed to corroborate the findings of the morphed and individually run models. These included: average and maximum strains in bone interface area and its entire volume, percentage of bone interface area and its volume strained up to and beyond 0.7%; implant average and maximum micromotions and finally percentages of implant area undergoing reported critical micromotions of 50 μm, 100 μm and 150 μm for bone ingrowth. Excellent correlation was observed in all cases.

In conclusion, the proposed technique allowed an automatic generation of FE meshes of the implanted femur as the implant position varies; the required computational resources were considerably reduced and the biomechanical response was evaluated. This model forms a good basis for the development of a tool for multiple statistical analyses of the effects of implant orientation in pre-clinical studies.
IN-VITRO AND IN-VIVO INVESTIGATIONS OF THE IMPACTION AND PULL-OUT
BEHAVIOR OF METAL-BACKED ACETABULAR CUPS
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Sufficient primary stability of the acetabular cup is essential for stable osseous
integration of the implant after total hip arthroplasty. By means of under-reaming the
cavities press-fit cups gain their primary stability in the acetabular bone stock. These
metal-backed cups are inserted intra-operatively using an impact hammer.

The aim of this experimental study was to obtain the forces exerted by the
hammer both in-vivo and in-vitro as well as to determine the resulting primary stability
of the cups in-vitro.

Two different artificial bone models were applied to simulate osteoporotic and
sclerotic bone. Polymethacrylamid (PMI, ROHACELL 110 IG, Gaugler & Lutz,
Germany) was used as an osteoporotic bone substitute, whereas a composite model
made of a PMI-Block and a 4 mm thick (cortical) Polyvinyl chloride (PVC) layer
(AIREX C70.200, Gaugler & Lutz, Germany) was deployed to simulate sclerotic
bone. In all artificial bone blocks cavities were reamed for a press-fit cup (Trident
PSL, Size 56mm, Stryker, USA) using the original surgical instrument. The impactor
of the cup was equipped with a piezoelectric ring sensor (PCB Piezotronics,
Germany). Using the standard surgical hammer (1.2kg) the acetabular cups were
implanted into the bone substitute material by a male (95kg) and a female (75kg)
surgeon. Subsequently, primary stability of the implant (n=5) was determined in a
pull-out test setup using a universal testing machine (Z050, Zwick/Roell, Germany).
For validation the impaction forces were recorded intra-operatively using the identical
press-fit cup design.

An average impaction force of 4.5±0.6kN and 6.3±0.4kN using the PMI and
the composite bone models respectively were achieved by the female surgeon invitro.
7.4±1.5kN and 7.7±0.8kN respectively were obtained by the male surgeon who
reached an average in-vivo impaction force of 7.5±1.6kN.

Using the PMI-model a pull-out force of 298±72N and 201±112N were
determined for the female and male surgeons respectively. However, using the
composite bone model approximately half the pull-out force was measured for the
female surgeon (402±39N) compared to the male surgeon (869±208N).

Our results show that impact forces measured in-vitro correspond to the data
recorded in-vivo. Using the osteoporotic bone model the pull-out test revealed that
too high impaction forces affect the pull-out force negatively and hence the primary
implant stability is reduced, whereas higher impact forces improve primary stability
considerably in the sclerotic bone model. In conclusion, the amount of impaction
force contributes to the quality of the obtained primary cup stability substantially and
should be adjusted intra-operatively according to the bone quality of each individual
patient.
A comparative kinematic study was carried out on six cadaver limbs, comparing tibiofemoral kinematics in five different conditions: unloaded, under a constant 130 N ankle load with a variable quadriceps load, with and without a constant 50 N medial and lateral hamstrings load. Kinematics were described as translation of the projected centers of the medial (MFT) and lateral femoral condyles (LFT) in the horizontal plane of the tibia, and tibial axial rotation (TR) as a function of flexion angle. In passive conditions, the tibia rotated internally with increasing flexion, to an average of -16° (range - 12/-20°, SD 3.0°). Between 0 – 40° flexion, the medial condyle translated forwards 4 mm (range 0.8/5.5 mm, SD 2.5 mm), followed by a gradual posterior translation, totaling -9 mm (range -5.8/-18.5 mm, SD 4.9 mm) between 40° – 140° flexion. The lateral femoral condyle translated posteriorly with increasing flexion completing -25 mm (range -22.6 – -28.2 mm, SD 2.5 mm). Dynamic, loaded measurements were carried out in a knee rig. Under a fixed ankle load of 130 N and variable quadriceps loading, tibial rotation was inverted, mean TR 4.7° (range -3.3°/11.8° SD 5.4°), MFT -0.5 mm (range = -4.3/2.4 mm, SD = 2.4 mm), LFT 3.3 mm (range = -3.6/10.6 mm, SD = 5.1 mm). As compared to the passive condition, all these excursions were significantly different: p=0.015, p=0.013, and p=0.011 for TR, MFT and LFT respectively. Adding medial and lateral hamstrings force of 50N each, reduced TR, MFT and LFT significantly as compared to the passive condition. In general, loading the knee with hamstrings and quadriceps reduces rotation and translation as compared to the passive condition. Lateral hamstring action is more influential on knee kinematics than medial hamstrings action.
The treatment of osteoarthritis using artificial knee joints is expected to expand further over the next decade. Increasingly, patients expect quicker rehabilitation, improved performance, and high durability. However, economic limitations require a reduced cost for each procedure, as well as early intervention and even preventative measures. The major goal of implant design needs to be a restoration of normal knee mechanics, whether by maximum preservation of tissues, or by guiding surfaces which replicate their function. In this paper it is proposed that total knees should exhibit anatomic knee mechanics, namely medial stability – lateral mobility.

Many studies in the past have shown that the neutral path of motion of the anatomic knee, is that the medial side remains relatively immobile in the AP direction, which will impart a feeling of stability, while the lateral side shows posterior femoral displacement with flexion, to obtain a high range of flexion. There is considerable rotational laxity about this neutral path to accommodate a range of positions and activities. Recent studies carried out in our laboratory using an up-and-down crouching machine, and other test machines, have conformed this mechanical behaviour. To further elaborate, we tested eight young male subjects in a 7T MRI machine, where compressive and shear loads were applied. AP displacements occurred laterally but not medially. We attributed this behaviour to the medial meniscus and the tibial bearing geometry under weight-bearing conditions.

On the basis of these various studies, we developed a method for the design of Guided Motion knees, which would be implanted without the cruciates, and which would restore anatomic knee mechanics. The method started with the femoral component, where the medial side had features to provide a continuous radius anteriorly, and distally to 75 degrees flexion when a post-cam would contact. This feature would prevent paradoxical anterior femoral sliding in early flexion. Multiple femoral positions were then defined for accommodating anatomic motion, in particular limited AP motion on the medial side, but posterior displacement laterally. Tibial bearing surfaces were generated accordingly. Tests were carried out on the crouching machine and on a Desktop TKR Test machine to compare the TKR motion with anatomic. Although not accurate in all respects, the Guided Motion designs were closer than models of standard TKR’s today. Such Guided Motion designs hold the promise for restoring anatomic knee mechanics and a normal feeling knee.
ASYMMETRIC BONY GEOMETRY AT THE ANTERO-LATERAL AND POSTRO-LATERAL FEMORAL HEAD-NECK JUNCTIONS

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Cam type femoro-acetabular impingement is defined by a reduced femoral head-neck offset and by excessive bone at antero-lateral femoral head-neck junction. Reconstruction of the femoral head-neck offset by removing the femoral bony prominence is a common treatment for cam type impingement. In many cases, the goal of this treatment is to make the antero-lateral head-neck offset symmetrical to the postero-lateral offset. However, guidelines for bony removal are not well established. The objective of this study is to examine if the antero-lateral and postero-lateral femoral offsets are symmetrical in normal healthy hips.

CT analyses of the anatomic geometry of the femoral head and neck were performed. Hip joints with any evidence of cartilage defects and impingement were excluded. Eight cadaveric hips (3 right and 5 left hips) were examined. The average age of the cadavers was 65.1±15.1 years. A peripheral QCT scanner was used which provided 0.2 x 0.2 x 2 mm resolution. To improve the resolution of the final result, each hip joint was scanned in three different scanning directions (sagittal, coronal, and axial scanning planes). A custom imaging fixture was built to position a joint sample in three different scanning planes and a custom irrigation system supplied saline to protect the sample from dehydration. A custom segmentation program was developed to delineate the bony contours of the femoral head and neck in a fully automated manner. The segmentation data from the three different imaging planes were merged and a 3D solid model of each hip joint was created. The prominence of the femoral head was determined by the distance of the 3D head from an ideal sphere fitted into the 3D model.

All the femoral heads were found to be asymmetric. Prominence of posteromedial femoral head averaged 0.105 mm more than the antero-medial femoral head. The antero-lateral head-neck junction was also found to be more prominent than the postero-lateral head-neck junction by an average of 1.09 mm. Asymmetry in the femoral head and femoral head-neck junction was a general finding in normal hip joints. The conventional approach of symmetric reconstruction of femoral head-neck junction may result in unnecessary removal of bone at the antero-lateral head-neck junction and potentially increase the risk of femoral neck fracture.
THE USE OF EXTENDED EXTENSOR MECHANISM ALLOGRAFT IN REVISION TKA WITH SIGNIFICANT TIBIAL BONE LOSS

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In patients with significant bone loss and a nonfunctioning extensor mechanism, the approach to revision is complicated. We describe a unique approach to solve this complex problem to help restore clinically satisfactory results. Our technique involves the use of a donor allograft that consists of proximal tibia along with the attached extensor mechanism (patellar tendon-patella-quadriceps tendon).

Five reconstructions utilizing bone allografts and extensor mechanisms were performed by two surgeons. Each has extensive surgical history on the affected knee and presented with gross instability, considerable bone loss, and significant extensor lag or total loss of extension. The implants used were press-fit stems with the tibial baseplate cemented into the allograft prior to implantation. In this series, either hinged or total stabilized prostheses were used.

The follow up ranged from 1 to 5 years. The only complication to date was reported in one patient who required irrigation and debridement with surgical wound closure after partial dehiscence. However the patency of the allograft was not disrupted. All prostheses have been noted to be stable with no signs of loosening.

This procedure presented should be considered a salvage procedure for bone stock and extensor mechanism deficiency in revision total knee arthroplasty. The advantage to our allograft is the inherent stability of the proximal tibia with the tibial tubercle and associated extensor mechanism. For patients with this complex deficiency, there has been no effective method of treatment and we advocate the use of this procedure to restore function and relieve pain to an otherwise grossly unstable and functionally limited joint.
The authors report that a less invasive approach and a "patella friendly" femoral TKA design significantly reduce the need for lateral retinacular release in primary total knee arthroplasty. They measured the release rate to be 1.8% for Vanguard TKA, significantly less than the previously reported 12.8% for Maxim TKA using a standard approach. The study supports the importance of surgical techniques and implant designs in minimizing lateral retinacular release.
LARGE FEMORAL HEADS IN PRIMARY TOTAL HIP ARTHROPLASTY REDUCE DISLOCATION

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With increased use of alternative bearings, surgeons have moved from utilization of 22, 26, 28 and 32mm heads to larger head diameters in total hip arthroplasty (THA). Reported benefits of large heads are enhanced stability secondary to the increased range of motion prior to impingement and the increased jump distance required for subluxation from the acetabulum. This study evaluates the use of large diameter heads in primary THA comparing the rate of dislocation to a published study from our practice as a historic control.

Between October of 2001 and October 2008, 2015 THA with large heads were performed in 1743 patients. Femoral head sizes ranged from 36 to 60mm, with articulations consisting of metal-on-poly, ceramic-on-poly, and metal-on-metal. Operative approach was 63% less invasive direct lateral, 10% anterior supine intermuscular, and 27% standard direct lateral. In 1999 (Mallory et al., Clin Orthop Relat Res) we reported a low incidence of 12 dislocations (0.8%) in 1518 primary THA done with smaller femoral heads via a standard direct lateral approach. In the current series with large heads, follow-up averaged 22 months. There has been one dislocation requiring revision (0.05%), representing a significant reduction from our earlier report (p=0.0003). Forty additional acetabular components have been revised (2.0%), with eight related to sepsis (0.4%), 23 aseptic loosening (1.1%), six metal sensitivity (0.2%), one pseudotumor (0.05%), one failure of ingrowth (0.05%), and one acute early migration (0.05%).

The use of larger diameter heads has significantly lowered our dislocation rate in primary THA with only one occurrence observed in 2015 cases, for a rate of 0.05% at two years average follow-up.
Femoroacetabular impingement (FAI) has been identified as the cause of idiopathic osteoarthritis in young patients. FAI is the result of decreased femoral head/neck offset ratio due to bony deformities and causes hip pain and labral tears. Because the unique design and bone preserving nature of metal-on-metal hip resurfacing implants, it is extremely difficult to correct extensive bony deformities associated with FAI. Poor patient selection and lack of correction/undercorrection of the underlying FAI deformity may lead to prosthetic impingement, extensive wear and metal ion release, component loosening, and subsequent implant failure. Hence, it is critical to define the patient population undergoing hip resurfacing. Because metal-on-metal hip resurfacing is performed more frequently in a younger population, we hypothesize that this patient population will have a larger proportion of femoroacetabular impingement than the general population and identification of this patient population is critical to the longevity of the implant.

A retrospective review of 153 hips undergoing metal-on-metal hip resurfacing was performed. 52 hips were excluded based on the exclusion criteria of inadequate preoperative films (6 subjects), existing hardware/history of trauma (11 subjects), or if the resurfacing was performed due to avascular necrosis secondary to trauma, steroids, etc (35 subjects). The remaining 101 hips (76 male, 25 female) had an average age of 51.8 years. Preoperative x-rays were utilized to assess impingement according to previously published methods. An acetabular index (AI) of $\leq 0^\circ$, center edge angle (CE angle) of $> 39^\circ$, a Sharp angle of $< 33^\circ$, and a present cross-over sign were considered pathologic findings for pincer impingement. Pathologic findings for cam impingement included the triangular index (TI; pathologic with $R = r+2\text{mm}$) and an $\alpha$ angle greater than 83° in men or 57° in women. Subjects were categorized as having impingement if they had one or more pathologic finding for either cam or pincer measurements and as having mixed impingement if they had one pathologic finding for both cam and pincer measurements. Prevalence rates were compared to published data for the general population.

Fifty-five subjects had at least one pathologic finding for cam impingement (18, 7, and 30 subjects had pathologic measurements for $\alpha$ angle, TI, and both measurements, respectively); 24 subjects had at least one pathologic pincer measurement (4, 6, 14, and 4 pathologic measurements for AI, CE angle, cross-over sign, and Sharp angle, respectively; 3 subjects had multiple pincer findings) 13 subjects were classified as having mixed impingement (with $\alpha$ angle and cross-over sign as the most prevalent cam and pincer measurements). When compared to published data for the general population (M: 17%, F: 4%), we found a significantly larger proportion of cam impingement in both males (60.5%) and females (36%) in patients undergoing resurfacing at our institution ($p<0.001$). There was also a significantly larger proportion of pincer impingement in our population (23.8%) than in the general population (10.7%) ($p=0.01$). There was no significant difference between our proportion of patients with mixed impingement (12.9%) and the general population (20.8%) ($p=0.150$).

The patient population for metal-on-metal hip resurfacing shows a greater prevalence of FAI than the general population. Because the femoral head/neck junction is preserved with hip resurfacing, patients undergoing this type of procedure might be at increased risk of impingement. Hence, it is important to assess the degree of FAI preoperatively. This will allow proper patient selection and careful planning of surgical correction of the underlying FAI deformity to increase implant longevity.
APPRIOPRIATE ENTRY POINT OF INTRAMEDULLARY GUIDES FOR FEMUR IN TOTAL KNEE ARTHROPLASTY: USING THREE-DIMENSIONAL DIGITAL TEMPLATING SOFTWARE – ATHENA”

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Introduction: Appropriate femoral component alignment is important for long-term survival of total knee arthroplasty (TKA). Valgus angle of femoral component is recommended as the angle between mechanical axis and anatomical axis of the femur. Intramedullary guide system is widely used for determining the valgus positioning of femoral component. Entry point of intramedullary guide is one of the key factors for determining valgus angle of femoral component. Some investigators have shown appropriate entry points of intramedullary guide, however, it is still unclear. In this study, appropriate entry point of intramedullary guide system was calculated using three-dimensional digital templating software “Athena” (Soft Cube, Osaka, Japan).

Method: Forty-one knees in 34 osteoarthritis patients except valgus deformity (30 females and 4 males, mean age 75.1 years) received TKA and were simulated using “Athena” from January 2009 to March 2009. All cases were grade III or IV in Kellgren-Lawrence index. Radiograph and CT scan image were used for determination of appropriate entry point of femur using “Athena”. The anatomical axis of femur was defined as a line connecting the midpoints of femoral AP and lateral diameter, at 60 mm and 110 mm proximal to the center of intercondylar notch. Two coordinate systems were configured as representation of entry points. One was at the center of intercondylar notch defined as the point of origin in axial view of CT image and the line parallel to the clinical epicondylar axis (cTEA) defined as X-axis. Another coordinate system was the same point of origin but parallel to the line between trochlear groove and the center of intercondylar notch (AP line) defined as Y-axis.

Result: In the coordinate system that defined the cTEA as the X-axis, the average of entry point was 0.3± 0.30 mm medial (range, -4.8~ 4.7mm) and 11.6 ± 0.52mm anterior (range, 3.1~ 16.5mm) to the center of intercondylar notch. In the other coordinate system that defined AP line as the Y-axis, the average of entry point was 2.6± 0.29 mm medial (range, -1.5~ 6.3mm) and 11.2±0.52 mm anterior (range, 2.8~ 16.0mm) to the center of intercondylar notch.

Discussion: In this study, the appropriate entry point of intramedullary guide was slightly medial and about 11mm anterior to the center of intercondylar notch on average. However, individual entry point varied considerably in distance. These data indicates that it is important to simulate the appropriate entry point of intramedullary guide in preoperative planning.
THE INFLUENCE OF COMPONENT SIZE ON THE OUTCOME OF HIP RESURFACING
WL Walter, A. Shimmin.

Reasons for failure of hip resurfacing arthroplasty include femoral neck fracture, loosening, femoral head osteonecrosis, metal sensitivity or toxicity and component malpositioning. Patient factors that influence the outcome include prior surgery, body mass index, age and gender, with female patients having two and a half times greater risk of revision by 5 years than males 1-4. In 2008, the Australian National Joint Replacement Registry (ANJRR) reported poorer results with small sizes, whereby component sizes 44mm or less have a five times greater risk of revision than those 55mm or greater 1. This finding is true for both males and females and after accounting for femoral head size, the effect of gender is eliminated.

We explore the relationship between component size and the factors that may influence the survivorship of this procedure, resulting in higher revision rates with smaller components. These include femoral neck loading, edge loading, wear debris production and the effects of metal ions, cement penetration, component orientation, and femoral head vascularity. In particular the way the components are scaled from the large sizes down to the smaller sizes results in some marked changes in interactions between the implant and the patient.

Wall thickness of the acetabular and femoral component does not change between the large and small sizes in most devices. This results in a relative excessively thick component in the small sizes. This may cause more acetabular and femoral bone loss, increased risk of femoral neck notching and relative undersizing of the component where acetabular bone is a limiting factor. Stem thickness does not change throughout the size range in many of the devices leading to relatively more femoral bone loss and a greater stiffness mismatch between the femoral stem and the bone. Relatively stiffness between the femoral stem and the bone is up to six times greater in the small size compared to the large size in some designs.

The angle subtended by the articular surface (the articular arc) ranges from 170° down to as low as 144° in the small sizes of some devices. A smaller articular arc increases the risk of edge loading, especially if there is any acetabular component malpositioning. Acetabular inclination has been related to metal ion levels5 and to the early development of pseudotumour6. An acetabular component with a radiographic inclination of 45° will have an effective inclination anywhere from 50° to 64° depending on the type and size of the component. This corresponds to a centre-edge angle from 40° down to 26°. The effective anteversion is similarly influenced by design.

The result of a smaller articular arc is to reduce the size of the `safe window’ which is the target for orthopaedic surgeons.

HIP GEOMETRY AND MODULAR NECKS IN TOTAL HIP ARTHROPLASTY
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Improving the adaptation between the implant and the patient bone during total hip arthroplasty (THA) may improve the survival of the implant. This requires a perfect understanding of the tridimensional characteristics of the patient hip. The perfect evaluation of the tridimensional anatomy of the patient hip can be done pre-operatively using CT-scan and in case of important hip deformation, a custom implant can be used. When this solution is not available, modular necks may be a reliable alternative using standard x-rays and intraoperative adaptation. We aimed to evaluate: 1) The usefulness of modular neck to restore the anatomy of the hip and 2) the short-term clinical and radiological results of a consecutive series of THA using modular neck.

We prospectively included 209 hips treated in our institution with a modular neck total hip arthroplasty between January 2006 and December 2007. All patients underwent a standard x-rays evaluation in the same center according to the same protocol. Pre-operatively, the frontal analysis of the hip geometry was performed and the optimal center of rotation, CCD angle, neck length and lever arm was analyzed to choose the optimal modular neck shape among 9 available shapes. These 9 frontal shapes are available in standard, anteverted or retroverted shapes, leading to 27 potential neck combinations. The mean patient age was 68 years and the mean BMI 26 Kg/m² All the procedures were performed supine using a Watson-Jones approach and the same anatomic stem. Intra-operatively the sagittal anatomy of the hip was analyzed and a standard, ante or retro modular necks were tested for the frontal shape defined pre-operatively.

According to the pre-operative frontal planning, non-standard necks were required in 24 % of the cases to restore the anatomy of the hip. Intra-operatively, a sagittal correction using anteverted neck was required in 5% of the cases and retroverted necks in 18% of the cases. Harris hip score improved from 56 to 95 points at last follow-up. No leg length discrepancy greater than 1 cm was observed. Restoration of the lever arm (mean 39.3 mm, range 30 to 49 mm) and of the neck length (55.2, range 43 to 68 mm) was adapted for 95% compared to the non operate opposite side. No loosening was observed.

According to our results modular neck combined are useful and reliable to restore optimal hip geometry and in this series 25% of the patient would have had imperfect extra-medullary hip geometry with a standard prosthesis. The good clinical and radiological short-term results should be confirmed at longer follow-up.
TOTAL HIP REPLACEMENT: EFFECTS OF BODY MASS INDEX, ACETABULAR MORPHOLOGY, AND BONE QUALITY ON STRESSES DEVELOPED IN CEMENT MANTLES

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Cemented total hip replacements (THR) are widely used and are still recognized as the gold standard by which all other methods of hip replacements are compared. [1]. Long-term results of cemented total hip replacements show that the revision rate due to aseptic loosening could be as high as 75.4% [2]. Moreover, high stresses developed in the cement mantle of reconstructed hips can lead to premature failure of the constructs [3]. Surgical fixation techniques vary considerably [4]. The aim of this study was to investigate the performances of different surgical fixation techniques of hip implants for patients with different body mass indices, bone morphology and bone quality, using finite element (FE) methods.

Anatomically correct reconstructed hemi-pelves were created, using CT-Scan data of the Visible Human Data set, downloaded to Mimics V8.1 software, where polylines of cancellous and cortical bones were created, and exported to I-Deas 11.0 FE package, where the reconstructed hemi-pelvis was simulated. Accurate 3D model of the hemi-pelvis was scaled up and down to create hemi-pelves of acetabular sizes of the following diameters: 46 mm, 52 mm, and 58 mm. Following sensitivity analyses, element sizes ranging from 1-3 mm were used. Material properties of the bones, implants and cement were taken from literature [5-7]. Bones of poor quality were simulated by a reduction in the elastic modulii of the cortical bone by 50%, the cancellous bone by 10% and the subchondral bone by 50% [5]. The nodes at the sacro-iliac joint areas and the pubic support areas were fixed. A compressive force of 3 times body weight was simulated at the hip joint. The nodes between the cancellous and subchondral bones were merged. Contact elements were used at the subchondral bone and cement mantle interface and between the femoral head implant and acetabular component. Dynamic in vitro tests, simulating forces acting on a hip joint during a gait cycle, were carried out on reconstructed synthetic bones, positioned on an Instron 8874 hydraulic machine, to verify the FE models.

The volume of cement stressed at different levels in groups of 0-1 MPa, 1-2 MPa and up to 11 and above MPa were calculated. Results of FE analyses showed that (1) an increase in the body mass index from 20 to 30 generated an increase in the tensile stress level in the cement mantle; (2) lower tensile and shear stresses developed in thicker cement mantles. For a 46mm acetabular size, peak tensile stresses decreased from 10.32MPa to 8.14MPa and peak shear stresses decreased from 5.36MPa to 3.67MPa when cement mantle thickness increased from 1mm to 4mm. (3) A reduction in the bone quality would result in an increase of approximately 45% in the cement mantle stresses. Results of in-vitro tests show that an increase in the cement mantle thickness improved fixation, corroborating with the FE results.

Performances of fixation techniques depend on the patient’s bone mass index, bone quality, bone morphology.

PROXIMAL FEMUR MORPHOLOGY AS A BASIS FOR HIP STEM DESIGN: AGE AND GENDER RELATED EFFECTS
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Introduction: In total hip arthroplasty (THA) an optimal fit and fill of the stem is essential for stable fixation. Thus femur morphology must be studied during pre-op planning (implant choice, sizing, positioning) or when a new stem is to be designed. Using plain AP x-ray analysis and the definition of a simple two-level parameter (canal flare index, CFI), Noble et al. identified an age related transition of the endosteal canal in AP view from a ‘champagne flute’ to a ‘stove pipe’. This reference data is 2D only, limited to the endosteal geometry and the elderly age range was defined as 60-90yrs so that the number of octogenerians >80yrs was too low to analyze morphological features of this rapidly growing and critical THA patient population.

In this study the endosteal and periosteal femur morphology of subjects >80yrs was studied using 3D CT analysis. It was the goal to a) describe age related changes of the femur morphology in 3D, b) to study the influence of gender c) to investigate if the results may affect fit & fill of current stem designs.

Methods: High-resolution CT-scans (slice thickness 1mm) were made of 170 consenting volunteers (m/f=101/69). The old group consisted of 119 subjects ≥80yrs (m/f=65/54, mean age: 84.1yrs [80-105]) and the young group of 51 subjects <80yrs (m/f=36/15, mean age 67.8yrs [39-79]). After thresholding the bone boundaries in Mímics V12 (Materialise, B), the endosteal and periosteal coordinates were analyzed for width, wall thickness, surface areas and various CFI’s relating dimensions at 20mm above LT and at a distal level (e.g. 60mm below LT, isthmus): Surface CFI (3D-CFI), frontal and lateral CFI based on the AP and ML projections (2D-CFI) and flaring in each of the four directions (1DCFI).

Results: The surface CFI was sign. lower in subjects ≥80yrs (5.08 ±1.23) than in subjects <80yrs (6.61 ±1.72, p<0.0001). This difference was sign. larger in females than in males (-32% vs. -17%), an observation valid with reference to any distal level. Equivalent age differences were found in both the frontal and lateral 2D-CFI as well as the medial, lateral and anterior 1D-CFI with changes in the anterior direction (-26.3%) being most dominant. In addition wall thickness was sign. reduced in the very elderly. E.g. at 20mm above LT, the medial wall measured 10.40mm at <80yrs and 7.61 at ≥80yrs, a reduction of -27% (p<0.001). In females (-35%) this difference was sign. larger (males: -23%, p<0.001) even when corrected for height.

Discussion: The age driven transition of proximal femur morphology continues in the octogenarian population. This transition is not limited to two discrete levels in the AP plane as previously reported but it is a continuous 3D phenomenon with high directional asymmetry. In addition, this transition also affects the wall thickness and the periosteal shape. Furthermore a strong gender effect was identified with aging females showing increasingly and asymmetrically less flaring and thinner walls. An age and gender specific THA stem design seems necessary to fit the morphed femur. The asymmetric transition prohibits the effective use of current implant systems with proportionally scaled dimensions but favors a matrix sizing scheme with frontal and lateral dimensions changing independently.
ASSOCIATION BETWEEN SQUEAKING AND IMPLANT DESIGN AND MATERIALS IN CERAMIC-CERAMIC TOTAL HIP ARTHROPLASTY
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While alumina ceramic-ceramic THA has been performed in the US for more than 12 years, the phenomenon of frequent, clinically reproducible squeaking is relatively new. The current study investigates the influence of implant design on the incidence of squeaking.

We reviewed implant information on 1275 consecutive revision THAs performed from 10/2002 through 10/2007 to identify any patients who had complained of squeaking or grinding. We also identified, 2778 consecutive primary ceramic-ceramic THA. Of these, we reviewed the clinical records of 1,039 patients (37%) to date. Any patient complaint of squeaking or grinding at the time of an office visit or by phone interview was recorded. Hips were divided into group 1: flush mounted ceramic liner; group 2a: recessed ceramic liner mated with a stem made of TiAlV and using a 12/14 neck taper; and group 2b: recessed ceramic liner mated with a stem made of a beta titanium alloy comprised of 12% molybdenum, 6% Zirconium, and 2% Iron and using a neck taper smaller than a 12/14 taper.

Of the revision THAs, 5 hips (0.4%) were in patients who had complained of squeaking or grinding. All 5 hips had a recessed, metal-backed ceramic liner and evidence of metallosis. In primary THAs, Group 2b had statistically significantly (p=0.04) more squeaking (7.6%) than group 2a (3.2%) which had statistically significantly (p=0.002) more squeaking than group 1 (0.6%).

Squeaking following ceramic-ceramic THA is associated with use of a recessed metal-backed ceramic liner in combination with a femoral component made of a betatitanium alloy and using a relatively small head-neck taper. Since all revised hips in our study had metallosis, it is possible that metal debris is adversely affecting the bearing and that the elevated metal rim combined with a small head neck taper and the beta-titanium alloy contribute to this problem. Use of bearings with a flushmounted ceramic liner mated with femoral components made of TiAlV and using a 12/14 taper appears to be prudent.
Originally introduced in 1997, porous tantalum is an attractive alternative metal for orthopaedic implants because of its unique mechanical properties. Porous tantalum has been used in numerous types of orthopaedic implants, including acetabular cups in total hip arthroplasty. The early clinical results from porous tantalum acetabular cups have been promising. The purpose of this study was to evaluate the presence of bone ingrowth and the incidence of osteolytic lesions in the acetabular cup - at 10 year follow up – in patients who had a total hip arthroplasty with a monoblock porous tantalum acetabular cup.

50 consecutive patients underwent a total hip arthroplasty with a monoblock porous tantalum acetabular component. All patients had computed tomography at an average of 10 years of follow-up. The computed tomography scan used a standard, validated protocol to evaluate bony ingrowth in the cup and for the presence of osteolysis.

The computed tomographic scans showed evidence of extensive bony ingrowth, and no evidence of osteolysis.

This study reports the 10-year results of a monoblock porous tantalum acetabular cup. This is the first study to evaluate a porous tantalum acetabular cup with the use of computed tomography. These results show that a porous tantalum monoblock cup has excellent bony ingrowth and no evidence osteolysis at 10 year follow-up. These results suggest that porous tantalum is an attractive material for implantation in young, active patients.
Orthopaedic grade ultra-high molecular weight polyethylene (UHMWPE) remains the preferred material for one of the bearing surfaces in total joint prostheses because of its high wear resistance and proven biocompatibility. Since the 1970s, UHMWPE has served as the only widely used bearing material for articulation with metallic components in total knee arthroplasty (TKA). However, polyethylene-related total knee failures have limited the lifetime of total knee joint replacements. The present study is focused on improving material integrity and reducing the probability of material failure. The hypothesis examined here is that there is a correlation between material failure of UHMWPE knee-joint components and the precise time-temperature history employed during fabrication, due to their strong effect on interparticle cohesion. The presence of fusion defects due to incomplete consolidation and incomplete polymer self-diffusion has been implicated in the failure of UHMWPE joints [1, 2]. Computer-aided methodology used in this study allowed quantitative prediction and optimisation of the extent of interparticle cohesion to ensure that inter-particle boundaries are of high integrity during moulding [3]. The current study has investigated the correlation between inter-particle cohesion governed by reputation theory and wear performance.

We have investigated the wear performance of direct compression moulded UHMWPE plates with different degree of inter-particle diffusion. Direct compression moulding was used in the present study because of its uniformly excellent surface finish which is better than machined surfaces. UHMWPE plates (44×24×3 mm) were direct compression moulded using GUR1050 powder (Ticona). Various moulding temperature (e.g. 145ºC, 150ºC, 175ºC) and dwell time (e.g. 15mins and 30mins) were investigated.

The wear tests were carried out at 37ºC using a Durham four-station multidirectional pin-on-plate machine, which generates both reciprocating and rotating motions simultaneously. The material combination of the flat-ended metallic indentors loaded against UHMWPE plates was constructed to mimic conformal contact conditions in knee prostheses. The articulating surfaces were lubricated using 25% diluted bovine serum. Meanwhile the experimental method was validated by evaluating the wear generation under the conventional configuration (i.e. UHMWPE pins on metal plates); results were comparable with the data in the literature [4].

For the direct compression moulded UHMWPE plates, experimental wear factors were determined and found to correlate well with numerically calculated degree of inter-particle diffusion. Increasing moulding temperature and dwell time decreased the wear factors and increased inter-particle diffusion. Surface structures were characterised before and after every 0.5 million cycles. The observed surface features on UHMWPE plates in ESEM and optical microscopy is very similar to those in retrieved knee prostheses [5] and those found in our own recent work with knee wear simulator testing.

REFERENCES
THE EFFECT OF PATELLAR EVERSION TO THE EXTENSION AND FLEXION GAPS IN TOTAL KNEE ARTHROPLASTY

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Purpose: The effect of patellar position on soft tissue balancing in total knee arthroplasty (TKA) is under debate. We developed the digital tensor system to measure the load (N) and the distance (mm) of extension and flexion gaps in medial and lateral compartment separately with setting of femoral component trial. The gap load and distance in extension and flexion position of posterior stabilized (PS) and cruciate retaining (CR) TKA in both patella everted and reset position were measured.

Materials and Methods: Thirty-four patients who underwent primary TKA for medial type osteoarthritis using medial parapatellar approach were included. The load was measured at the gap distance, which is equal to the sum of implants including polyethylene insert.

Results: In extension, there was no significant difference between the load in patella everted and reset position in both PS-TKA and CR.-TKA. In flexion, there was a significant decrease of the load, which is comparable to the increase of gap distance of approximately 2mm, by resetting the patella from eversion in PS-TKA. There was, however, no significant difference in CR-TKA by resetting the patella. There was no significant difference in the ratio of medial / lateral load in both PSTKA and CR.-TKA.

Conclusion & Significance: Soft tissue balancing of PS-TKA with medial parapatellar approach should be performed after resetting the patella.
THE AVON PATELLOFEMORAL ARTHROPLASTY: AVERAGE 5 YEAR RESULTS FROM AN INDEPENDENT CENTRE
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Purpose of Study: To identify the functional outcome, quality of life and prosthesis survivorship in patients who have undergone the Avon patellofemoral arthroplasty at an independent centre.

Method and Results: Sixty-three patellofemoral arthroplasty (PFA) procedures were undertaken on 44 patients between May 1998 to May 2007. The primary and secondary outcome measures were knee function and quality of life, respectively. These outcomes were determined using the Oxford Knee Score (OKS) and EQ-5D and visual analogue score. Out of the forty-four patients 6 were deceased and 6 were lost to follow-up. Therefore, thirty-two patients (50 PFAs) were included; nine males and 23 females. Seventeen patients had bilateral PFA. The mean age of the patients was 65.8 years (SD 9.2). Follow-up averaged at 5.34years (range 2.1-10.2years) (SD2.64). The Oxford Knee Scores in this population showed a bimodal distribution. One group centred around 35 and the other around 60. The median Oxford knee score was 42.5 (IQR 34.25 to 54.25). Two sample t-test analysis of the population, divided as those above and below an OKS of 42, showed that follow-up time and age, did not differ between the groups (p=0.325, p=0.255 respectively). The quality of life outcome scores were significantly lower for bilateral compared to unilateral patients, with median scores of 50 and 72.5 respectively (p=0.03829). The cumulative survival at 5 years for those with minimum 5 year follow-up (32 out of 50 PFA) was 100%. Three knees in total were revised. One patient developed bilateral tibiofemoral osteoarthritis, requiring revision to total knee replacement (TKA) at seven and 10 years. Another had persistent anterior knee pain and was converted to a TKA.

Conclusion: The Avon patellofemoral arthroplasty provides good functional outcome. The survivorship rate is promising although longer follow-up is required. Prudent patient selection is needed avoid high rates of revision to TKA.
ASPIRIN VERSUS WARFARIN FOR VENOUS THROMBOEMBOLISM (VTE) PROPHYLAXIS AMONG PATIENTS RECEIVING ELECTIVE TOTAL HIP OR KNEE JOINT REPLACEMENT: AN OBSERVATIONAL STUDY (AVP STUDY)

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Current orthopedic practice requires consideration of apparently contradictory recommendations regarding VTE prevention among THR/TKR patients. American College of Chest Physicians (ACCP) 8th Clinical Practice Guidelines for the Prevention of Venous Thromboembolism recommend against aspirin for VTE prophylaxis in any patient1. The American Academy of Orthopedic Surgeons (AAOS) Guideline recommends pulmonary embolism risk stratification, then implementation of one of many possible courses including the use of aspirin2.

We conducted a prospective observational study among consecutive patients presenting for total hip or knee arthroplasty. Pre-operative PE risk stratification was performed at the discretion of the surgeon. Patients identified as usual risk for PE received aspirin. Patients considered being at elevated risk for PE received warfarin. This observational study protocol called for one year of data collection. At approximately 8 months 656 patients were enrolled, and the surgeon principally implementing PE risk stratification and administration of aspirin chose to stop enrolling patients due to a high incidence of pulmonary emboli. One hundred fifty five patients received thromboprophylaxis with aspirin 600 mg PR in the PACU, then 325 mg BID for one month (reduced to 81 mg daily if GI symptoms were present). The remaining 501 patients received an ACCP-based warfarin protocol managed by a pharmacist anticoagulation management service.

Our hypothesis is the null hypothesis; that an AAOS-based approach to hromboembolism prevention is not inferior to an ACCP-based approach. The a priori primary endpoints of the AVP Study are clinically overt VTE, DVT, PE, major bleeding, and death. All patients will receive a 90 day follow-up questionnaire in person or by telephone. Additionally, the electronic medical record of Intermountain Healthcare will be interrogated for ICD-9 codes germane to the outcomes of interest.

Ninety day follow-up has been completed for approximately 140 patients. The dataset will be locked upon completion of the 90 day follow-up among those patients who last received PE risk stratification and aspirin therapy (data lock early June, 2009). We anticipate preliminary data available for report by July, 2009.

References
EARLY RESULTS OF THE POSTERIOR CRUCIATE REFERENCING TECHNIQUE AND POSTERIOR SLOPED TIBIAL INSERTS ON TOTAL KNEE ARTHROPLASTY
David J. Covall, Bernard Stulberg and Jay Maybrey,

INTRODUCTION; The Posterior Cruciate Referencing Technique (PCRT) for total knee arthroplasty (TKA) uses innovative instrumentation and tibial inserts with varying posterior slopes, and is designed to maximize motion and stability in cruciate-retaining knees, while preserving bone and ligament integrity. This study evaluated early clinical results for this technique.

METHODS: An IRB-approved, retrospective, single-site, single-surgeon study was conducted in 2009. 50 patients were put into two groups: Group 1 included patients undergoing CR TKA using standard technique and implants and Group 2 included patients undergoing CR TKA using PCRT. Demographics, surgical time, length of stay (LOS), range of motion, and Oxford Knee Scores (OKS) were collected.

RESULTS: Data sets were complete on 41 patients. Follow-up averaged 14 months for Group 1 and nine months for group 2. Both groups had a mean age of 66.4, were 51% female, and had an average BMI of 30.6. LOS was 1.25 days for Group 1 and 1 day for Group2 (p=0.011). Surgical time was 48 minutes for Group 1 and 46 minutes for Group 2 (p=0.184). Average flexion was 118° for Group 1 and 123° for Group 2 (p=0.073). OKS were 92-94% good and excellent with a mean of 20.4 for both groups.

CONCLUSIONS: The learning curve for PCRT and the associated instrumentation and implants did not adversely affect clinical results. Instead, the data indicated a small savings in surgical time and a moderate, but not statistically significant, increase in flexion. LOS, however, was significantly shortened. PCRT may allow for better PCL function while preserving bone and reducing surgical manipulation, and with tibial inserts of varying posterior slopes may improve flexion, stability, and function in CR TKA. Further study is warranted.
The purpose of this double-blinded prospective study was to evaluate the effectiveness of electromyography (EMG)-guided preoperative femoral nerve block (FNB) for postoperative analgesia in total knee arthroplasty (TKA).

Forty knees of primary TKA by one surgeon were included in our study. One doctor performed a single injection FNB with an EMG guide in EMG group (23 knees) and with a blind maneuver in control group (17 knees). The same 10ml of 0.375% ropivacaine was injected in both groups. Same postoperative rehabilitation protocol was applied to all patients. Continuous passive motion was started at postoperative 1st day and weight bearing was started as soon as possible.

Intravenous patient-controlled analgesics which contained 30mg of morphine were used until postoperative 72 hours and no additional intravenous, intramuscular or oral analgesics were used. Pain was evaluated by Visual Analogue Scale (VAS) and Postoperative Pain Score (PPS) at postoperative 4, 24, 48 and 72 hours. The amount of opioid consumption and complication were compared between two groups. VAS score was 6.8 in EMG group and 8.0 in control group at postoperative 4 hours, 6.2 and 7.1 at postoperative 24 hours, 5.3 and 5.9 at postoperative 48 hours, and 4.6 and 5.7 at postoperative 72 hours, respectively. PPS was 2.2 in EMG group and 2.2 in control group at postoperative 4 hours, 2.1 and 2.1 at postoperative 24 hours, 1.6 and 1.7 at postoperative 48 hours, and 1.4 and 1.6 at postoperative 72 hours, respectively. The amount of opioid consumption was 6.0mg in EMG group and 7.2mg in control group during postoperative 24 hours, 2.7mg and 3.2mg during postoperative 24-48 hours, and 1.7mg and 3.2mg during postoperative 48-72 hours, respectively. There was no complication in either group.

Pain tended to decrease more in EMG group than control group, especially VAS at postoperative 4, 24 and 72 hours (p<0.05). The demand of opioid was significantly smaller in EMG group during postoperative 24 hours and 48-72 hours (p<0.05). EMG-guided single FNB before TKA allowed better postoperative pain relief and reduced the demand of pain killer.
COMPUTATIONAL TOOLS FOR DESIGN PHASE EVALUATION OF TOTAL KNEE REPLACEMENT KINEMATICS
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Design phase evaluation of potential implant designs requires verified computational and experimental models. Computational models are important where parametric evaluation of geometric features experimentally is both cost and time-prohibitive due to the need to manufacture complex parts, and provide information not easily measured experimentally, such as internal stresses/strains in the implant or bone. However, before implementation into the design process, a thorough verification/validation is required. In this study, a finite element model of the Kansas knee simulator (KKS) was developed and a systematic verification of predicted joint kinematics was performed by comparison with experimental measurements, including evaluating the patellofemoral joint first in isolation, followed by whole joint kinematic comparisons.

Four unmatched, healthy cadaver knees (average age 63 yrs) were mounted in the KKS to reproduce a simulated gait and deep knee bend activity in their natural and implanted states. Finite element models of the KKS assembly and the four cadaver specimens in their natural and implanted states were created. Isolated patellofemoral kinematics were initially verified during simulated deep knee bend. Average RMS differences between predicted and experimental natural patellar kinematics were less than 3.1° and 1.7 mm for rotations and translations, respectively, while differences in implanted kinematics were less than 2.1° and 1.6 mm between 10 and 110° femoral flexion. Similar agreement was found with the subsequent whole joint simulations. Deep knee bend tibiofemoral internal-external (IE) and varus-valgus (VV) rotations had average RMS differences from experimental measurements of 1.5 ± 0.4° and 0.9 ± 0.5°, respectively. Anterior-posterior (AP), inferior-superior (IS) and medial-lateral translations matched within 1.8 ±0.8 mm, 1.2 ±0.7 mm, and 0.6 ±0.1 mm, respectively.

The experimental and verified computational tools can be used in harmony for pre-clinical assessment of implant designs; the computational model allows rapid screening of implant geometry or alignment issues and provides additional insight into joint mechanics such as implant stresses or bone strains, while the experimental simulator can subsequently be utilized to assess in cadavera only the most promising designs or features identified.
COMPARISON OF COMPUTERIZED MEASUREMENT OF POLYETHYLENE WEAR WITH MRI DETECTION OF PARTICLE DISEASE
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Introduction: Computer-based wear analysis is currently the most accurate method for determining the in vivo wear rates of polyethylene liners during total hip arthroplasty. MRI of a total hip is emerging as the best method for determining the intra-articular volume of particulate debris. The purpose of this study is to determine if there is a correlation between polyethylene wear and the development of particle load in patients with highly crosslinked (HXLP) liners.

Materials and Methods: 20 well-functioning total hips (7 metal heads against HXLP liners and 13 ceramic heads against HXLP liners) in 18 young active individuals were analyzed using the following criteria: femoral head penetration of the liner was measured by Roman (ROntgen Monographic ANalysis) software and particulate load was calculated by MRI criteria as described by Potter et al. Clinical and radiographic analyses were performed using HSS, WOMAC, and criteria defined by DeLee, Charnley, and Engh. The average age of the patients was 57 (Range 45-67) and average follow-up was 1.6 y (range 1.0 – 3.0 y).

Results: All implants appeared well osteointegrated with no radiographic evidence of osteolysis. All patients had well-functioning total hips with a greater than one mile daily walking tolerance. A trend towards correlation was observed between increased polyethylene wear and increased particulate volumes. Average HXLP wear was 0.03 mm (range -0.19 to 0.27 mm) and average particle volume was 841 (range 6951 to 0). One patient in particular recorded 0.27 mm of polyethylene wear, mild particle disease and a particle disease volume of 3321 at 1.6 years follow-up. However, statistical significance could not be achieved with these data points.

Conclusions: There appears to be a relationship between polyethylene wear as measured by computer-based systems and particulate volume as measured by MRI. Limitations of the current methodology include the inability of computer-based systems to detect precise levels of minimal wear with HXLP liners, and the highly sensitive MRI images which may be detecting more than just wear debris.
EARLY CLINICAL OUTCOMES OF MODULAR BICOMPARTMENTAL ARTHROPLASTY

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Bicompartmental arthritis involving the medial and patellofemoral compartments of the knee is a common pattern that has often been treated with total knee arthroplasty. However, the success of unicompartmental and patellofemoral arthroplasty for unicompartmental arthritis, as well as an interest in bone and ligament conservation for earlier stages of arthritis, has led to an interest in bicompartmental arthroplasty. The purpose of this study is to review the clinical, functional, and radiographic results of modular bicompartmental arthroplasty.

Twelve consecutive modular bicompartmental arthroplasties, using separate contemporary unicompartmental tibiofemoral and patellofemoral prostheses, were performed by the senior author. Clinical and functional data including range of motion (ROM), WOMAC and Knee Society (KS) scores were collected pre-operatively and post-operatively at 6 weeks, 12 weeks and annually. Radiographs were taken preoperatively and at the 6 week and annual postoperative visits. The average patient age at the time of surgery was 63 (range, 47 to 72); seven patients were women.

At most recent follow-up, the mean knee ROM improved from 100 degrees of flexion pre-operatively (range, 90 to 110) to a mean of 126 degrees of flexion (range, 115 to 130) (p < 0.0001). Improvements in WOMAC scores were statistically significant (p = 0.02). Statistically significant improvements in Knee Society scores were also observed (p = 0.03). No radiographs showed evidence of loosening, polyethylene wear or progressive lateral compartment degenerative arthritis. There were no complications in the peri-operative period.

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.
MID-TERM RESULTS OF HYBRID TOTAL HIP ARTHROPLASTY FOR TREATMENT OF OSTEOARTHRITIS SECONDARY TO DEVELOPMENTAL DYSPLASIA OF HIP—CHINESE EXPERIENCE

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Objective Considering the high incidence and misdiagnostic rate of developmental dysplasia of hip (DDH) in China, some patients suffer from severe pain in the hip at early age, and a total hip arthroplasty would be necessary. To our knowledge, the intermediate-term (equal to or more than five years) results of total hip arthroplasty (THA) in patients with osteoarthritis secondary to developmental dysplasia of the hip has not been studied in China previously. This study evaluated more than five-year clinical and radiographic outcomes associated with total hip arthroplasty (THA) in a consecutive series of patients with osteoarthritis secondary to developmental dysplasia of the hip.

Methods From February 2000 to July 2002, 55 patients (69 hips) underwent THA in our hospital were involved in this study. Clinical outcomes were evaluated according to Harris evaluate score. Components migration, periprosthetic bone changes, the polyethylene wear rate were measured radiologically. Kaplan-Meier analysis was performed to evaluate the survival of the acetabular and femoral component. End point was obvious radiological loosening or revision either or both of the acetabular and femoral component for any reason.

Results Forty-five patients (57 hips) were followed up at least 5 years. The average preoperative Harris hip score was (46.19±18.01) points, which improved to (91.78±3.52) points at final follow-up. There were 48 excellent hips (84.21%), 7 good hips (12.28%), 2 fair hips (3.51%) and no poor hip. There is no significant difference of Harris score between the dysplasia group, the low dislocation group and the high dislocation group (P>0.05, ANOVA). The mean polyethylene liner wear rate was (0.27±0.14)mm/year. According to the statistical relevant analysis, the wear rate of the polyethylene liner had relationship with the age (r=−0.288, P=0.040), the abnormal abduction angle of the acetabular cup (r=0.317, P=0.023) and the osteolysis rate (r=0.573, P=0.026), while had no significant relationship with the thickness of the polyethylene liner (P=0.326), gender (P=0.097), DDH classification (P=0.958) and the Harris score (P=0.598). There are 5 pelvic osteolysis and 8 proximal femoral osteolysis. Using loosening or revision as the end point for failure, the survival rate of both components was 1.0 (95% confidence interval, 0.98-1.00).

Conclusions In conclusion, improved surgical technique and design in the components provided favorable mid-term results in Chinese patients with osteoarthritis secondary to developmental dysplasia of the hip. Bulk autogenous or allografting is not needed if more than 70% of the acetabular component is covered by host bone. Although the Asia life style includes more squatting and cross-legged, the results of this series in Chinese population are comparable to the satisfactory results of other reported DDH series whose patients are mainly western people. The mid-term results of THA are equivalent in the group of patients with dysplasia, low dislocation, and high dislocation types both in acetabular and femoral components. However, the authors continue to be anxious about the high rate of liner wear and osteolysis, which deserve the necessary long-term follow-up.

【Key words】Arthroplasty, replacement, hip; Hip dislocation, congenital; Follow-up studies.
A1230

ROTATING HINGE KNEE RECONSTRUCTION INCORPORATING AN IRREMOVABLE TIBIAL NAIL
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The presence of an unremovable cemented tibial nail presents a unique challenge for limb salvage reconstructions utilizing a rotating hinge knee. All manufacturers’ designs except Link America incorporate a vertically-oriented rotational channel in the proximal tibia to provide the housing for a rotational axis stem. Such channel placement may be impossible in patients with pre-existing tibial hardware that obliterates the proximal tibial intramedullary canal. The Link America design utilizes a superiorly-projecting rotational stem that articulates with a housing located on the rotational yoke component; however it requires an intramedullary tibial stem for component stabilization. Thus all currently available rotating hinge knees require placement of a stem or a stem equivalent into the tibial intramedullary canal.

We describe a limb salvage case employing a Link America rotating hinge knee with a tibial component incorporating a custom hollow stem in a patient with an unremovable centralized, straight, cemented tibial nail. This reconstruction was required following an intra-articular fracture of a successfully incorporated massive proximal tibial osteoarticular allograft. The allograft had been implanted seven years previously following resection of a proximal tibia osteosarcoma.

This custom device allowed a relatively simple limb salvage reconstruction with good results and only a two day hospital stay.

This custom hollow-stemmed device allowed limb salvage in a situation that otherwise would have required either an amputation or resection of a healed tibial allograft that had successfully incorporated, replacing approximately 50% of the length of the tibia shaft. While rarely required, such an implant can allow a relatively simple and straight-forward functional salvage of an extremity in those patients whose only other choices for limb salvage include much more extensive bone resections and complex reconstructions. The potential for subsequent articular level failure should be considered whenever utilizing an osteoarticular allograft. A cemented, retrograde inserted, intramedullary nail can provide reliable internal fixation of such an allograft. If such fixation is selected, a straight intramedullary nail (as in this case) should be utilized, so that the intramedullary device is centered in the proximal tibia. This will allow for future revision to a total knee with a hollow stemmed tibial component should the need arise.
IN VIVO COMPARISON OF WEAR PARTICLES BETWEEN OXIDIZED ZIRCONIUM AND COBALT-CHROME FEMORAL COMPONENTS IN THE SAME DESIGN OF TKAs
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Although total knee arthroplasty (TKA) has been a reliable procedure providing durable pain relief, polyethylene (PE) wear remains a major limitation of the long-term success of TKA. One potential method of lowering PE wear in TKA is to use oxidized zirconium (OxZr)-bearing surface. Although wear simulating testing of an OxZr counter surface of femoral component produced less PE wear and fewer particles than did cobalt-chrome (Co-Cr) counter surface of femoral component [1-4], this finding has not been demonstrated in vivo to our knowledge.

We measured in vivo PE wear by isolating and analyzing PE wear particles in synovial fluid from wellfunctioning TKA [5]. The purpose of the current study was to determine the size, shape, and amount of PE wear particles isolated from synovial fluid of patients who underwent a bilateral simultaneous TKA prosthesis, but different materials of femoral components.

We performed a bilateral simultaneous TKA in 100 patients (200 knees) who received an OxZr femoral component in one knee and a Co-Cr femoral component in the other. Mean age was 55.6 (44-60) years. Synovial fluid was obtained from 28 patients (56 knees) who had undergone a simultaneous bilateral TKA under completely sterile conditions at one or two years after the operation. Randomization to an OxZr or Co-Cr femoral component was accomplished with use of a sealed study number envelope, which was opened in the operating room before the skin incision had been made. After the opening the randomization envelope, the first knee received prosthesis indicated by the envelope (OxZr or Co-Cr component) and the contralateral (second TKA) knee received the other prosthesis (OxZr or Co-Cr component).

All operations were performed by one surgeon using the same design of total knee prosthesis: Genesis II (Smith and Nephew, Memphis, Tennessee). Only the material of the femoral component differed between two groups. The preoperative diagnosis was osteoarthritis in all patients. Preoperative and post operative KS and HSS knee scores, KS functional scores and UCLA activity scores were evaluated.

The amount of polyethylene wear particles in the aspirated synovial fluid sample was analyzed by thermogravimetric analysis (TGA) using a TGA instrument (TGA/SDTA 84le model, Mettler Toledo CO., Greifensee, Switzerland). The weight of the sample solution was measured before and after removing the organic content by heating the sample solution. The sample solution was casted onto petri dishes. The petri dish was covered and kept in a dry oven at 60°C for 2 days. While the sample solution was kept in a dry oven for 2 days, a small hole was made on the cover of the petri dish to allow water to evaporate slowly for 2 days. After this procedure, the cover of petri dish was removed and TGA sample was dried at 60°C for another 2 days. After the sample was completely dried out, the dried sample was measured using analytical balance.

TGA was used to determine the weight change profiles of polyethylene subject to heating under a nitrogen atmosphere. The nitrogen flow rate was kept constant at 50mL per minute. TGA data were taken at heating rate as 5°C per minute in the temperature range of 20°C to 1000°C. The weight loss data were recorded as a function of time and temperature using special software in computer. When the temperature reached to the point of decomposition of the sample, the sample started to lose weight. By calculating the weight of the sample around the temperature which led
to start to decomposition, real amount of polyethylene in the sample was measured. The size and shape of PE particles were examined using scanning electron microscopy (JSH-6360A model, Jeol Co., Tokyo, Japan). The samples were coated using a platinum sputtering machine for 20 sec.

ANOVA, nonparametric chi square test, nonpaired t-test and Mann-Whitney U-test were used for statistical analyses. Differences of P<0.05 were considered statistically significant.

Mean preoperative KS (27.5 vs 27.2 points) scores, HSS (51.1 vs 51.2 points) knee scores, KS functional scores (55.4 vs 55.4 points) and UCLA activity scores (2.8 vs 2.8 point) were not significantly different between two groups. Mean postoperative KS (93 vs 92 points), HSS knee scores (90 vs 89 points), KS functional scores (78 vs 78 points), and UCLA activity scores (7.8 vs 7.8) were not significantly different. Mean weight of the polyethylene particles was 0.0219 g (SD, 0.0058) in the Co-Cr femoral component groups and it was 0.0214 g (SD, 0.005) in the OxZr group. This difference was not significant (P=0.711139, paired t-test). The size of particles was not different between the two groups. Also, shape of particles was not different between the two groups.

Under the condition and the duration of this study in this specific group of patients, TKA with OxZr or Co-CR femoral knee component had excellent clinical and radiographic outcomes with no osteolysis. While the wear simulator test in vitro demonstrated significant decrease in PE particles in the knees with an OxZr femoral component, our study in vivo revealed that total particle weight, size, and shape of PE wear particles were similar in the knees with an OxZr femoral component and in those with a Co-Cr femoral component.
The clunk syndrome is a rare complication of the posterostabilized total knee arthroplasties. In the literature, there is a lot of aetiologies described concluding to a multifactorial disease. The aim of our study is to analyse the risk factors described in the literature in a serie of clunk syndrome occurring in three different prosthesis.

We retrospectively analyzed all our cases of clunk syndrome. We compared radiographic values before and after the intervention: the Insall-Salvati ratio, the joint line modification, the thickness of the patella and position of the tibial tray. We compared the appearance of the clunk in three different types of new generation prosthesis: Scopio NRG (Stryker), Legacy (Zimmer) and Sigma (DePuy). The bone scan was done preoperatively to confirm diagnosis.

There are four cases of clunk in each group of prosthesis which represents an mean incidence of 0.5%. All the clunks occurred in female patients. There is three bilateral cases and one homolateral recurrence. We find no difference in the preoperative values compared to the postoperative status. There is no difference between the three groups. The bone scan was done in eight cases and returned positive in seven cases.

All our cases of clunk syndrome occurred in female patients which is our first risk factor. Doing a clunk syndrome on one side is a great risk factor of doing a clunk on the other side if implanted. The diagnosis of the syndrome is mostly clinical but the bone scan is frequently positive.

The patellar clunk syndrome remains a rare complication of posterostabilized TKA. Being a woman and one episode of clunk are two risk factors. In presence of symptoms, the bone scan is a reliable preoperative exam to confirm the diagnosis.
PARTICLE DEBRIS ANALYSIS AND BIOLOGICAL RESPONSE OF MOTISTM ACETABULAR CUP WEAR DEBRIS OVER A 25 MILLION CYCLE SIMULATOR TEST
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Particulate debris created during a fiber-filled PEEK material (MOTISTM) rubbing on a ceramic femoral head in a hip wear simulation study was characterized. The particles were cleaved from the protein lubricant with a double enzymatic protocol and then sized using two different techniques. The sizes obtained were verified using an AFM imaging technique.

Many metal-on-UHMWPE joints ultimately fail due to late aseptic loosening. This occurs due to the particulate debris built up in the peri-prosthetic area. The body’s natural immunological response leads to bone resorption, the prosthesis becomes loose and severe pain can then necessitate revision. It is therefore important to characterize the wear particles of novel materials in order to understand their biological impact.

Particles were generated in a Durham hip wear simulator from a MOTISTM acetabular cup articulating against a ceramic femoral head for 25 million cycles. The samples were generated in 500 ml of bovine serum lubricant (17 g/l protein) and a 10 ml sample of this lubricant was analyzed.

A double enzymatic protein cleavage protocol was used as it was shown to be the least harmful to the particles.

A bi-modal distribution of sizes was seen with a large number of particles of 100 nm and a large number at the two micron size range. AFM results verified the size of the particle distribution and also showed that the smaller particles were round to oval and the larger particles were long and thin. No carbon fibers were evident in the AFM images. Although the wear rate over the 25 million cycles remained low and linear, the average particle size tended to increase over the 25 million cycles whilst the volume of the particles decreases over the period.

Howling studied particle debris from a pin-on-plate carbon fiber reinforce PEEK against ceramic test using a 6M KOH protocol and resin embedded TEM analysis. This method only allowed around 100 particles to be imaged at a time, no size distribution was given. Cytotoxicity was also tested using U937 monocyctic cells indicating that MOTISTM has no cytotoxic effects such as necrosis.

References
LONG-TERM RESULTS OF CEMENTED PRIMARY TOTAL HIP ARTHROPLASTY FOR DYSPLASIA, WITH STRUCTURAL AUTOGRRAFT FIXED WITH PLLA SCREWS
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Poly-l-lactic acid (PLLA) is characterized by its biocompatibility and biodegradability, and is used clinically. In our hospital, we started to use PLLA screws instead of metallic or ceramic screws in the fixation of acetabular bone grafts in total hip arthroplasty (THA) in 1990, because there were concerns about the use of rigid and nonbioabsorble screws, which might contribute to the absorption of the grafted bone and induce metallosis or third-body wear when breakage of the screws occurs. The purpose of this study was to review a series of cemented THA for dysplasia, with structural autograft fixed with PLLA screws. We focused on the survival rate of the acetabular component and radiological change of the grafted bone–socket interface.

This study included 104 consecutive cemented total hip arthroplasties (80 patients) performed between July 1990 and December 1995 in our hospital. All patients were followed over 10 years and reviewed retrospectively. The grafted bone trimmed from the excised femoral head was fixed rigidly with 1 or 2 PLLA screws (cancellous lag screws 6.5 mm in bore diameter and 4.1 mm in grove diameter) (Fixsorb; Takiron Co., Ltd., Osaka, Japan).

X-ray photographs taken just after the primary operation showed an obscure but still visible radiolucent region corresponding to the inserted PLLA screws in many cases. However, X-ray photographs at the final follow-up showed an unclear radiolucent zone at the sites of the PLLA screws, and the osteosclerotic line surrounding the site where the radiolucent zone had been found was confirmed in only 4 cases. Bone union was confirmed radiologically at the grafted site in every case, and there were no cases of early collapse or extravasation of the grafted bone. No positive resorption of the grafted bone was observed in any case. Kaplan–Meier survivorship analysis of socket revision, radiological loosening of the socket, and the appearance of a radiolucent line > 1 mm in the graft–socket interface as the endpoints indicated survival rates of 99%, 97.1%, and 63.5% at 10 years, and 96.6%, 90.2%, and 56.1% at 15 years, respectively.

The results of this study indicated that PLLA screws are safe and useful for the fixation of acetabular bone graft concomitant to cemented THA with a careful rehabilitation program. However, because of concern about the mechanical insufficiency of the PLLA screws for THA with an early weight-bearing rehabilitation program, we have used mechanically stronger and bioabsorbable screws made of forged composites of hydroxyapatite and PLLA since 2003.
MOBILE-BEARING KINEMATICS IN PCL-RETAINING TOTAL KNEE ARTHROPLASTY. A STUDY OF 51 CASES.
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Mobile-bearing total knee arthroplasty was developed to provide low contact stress and reasonably unrestricted joint motion. We studied the results of a cementless, posterior cruciate ligament (PCL)-retaining total knee arthroplasty (TKA), with a mobile-bearing insert in rotation and anterior-posterior (AP) translation (Innex® Anterior-Posterior Glide, Zimmer).

Kinematic analyses were performed on a series of 51 primary TKA. The patients’ mean age was 71±8 years at operation. Patients were studied at 23 months average follow-up with weight-bearing radiographs at full-extension, 30° flexion and maximum flexion (“lunge” position). Three dimensional position and orientation of the mobile-bearing relative to the femoral and the tibial component during flexion were determined using model-based shapematching techniques.

The average weight-bearing range of implant motion was 110°±14°. In flexion, the mobile-bearing was internally rotated 3°±3° with respect to the femoral component (p<0.0001) and the tibial tray was internally rotated 5°±7° with respect to the mobile-bearing (p<0.0001). On average, the mobile-bearing did not translate relative to the tibial base plate from full extension to 45° flexion [0±2 mm (range −5 mm to 6 mm)]. However, the mobilebearing did translate anteriorly 1±2 mm (range −2 mm to 9 mm, p<0.0001) between 45° flexion and maximal flexion.

We conclude that the mobile-bearing insert showed a progressive increase in internal rotation during flexion. Most of this rotational mobility occurred between the mobile insert and the tibial base plate. With flexion, AP translation did occur between the femoral component and mobile-bearing, and between the mobile-bearing and tibial base plate, but mobile-bearing translation was unpredictable with this unconstrained design.
CONTROL-MATCHED EVALUATION OF PATELLAR CREPITUS IN TOTAL KNEE ARTHROPLASTY
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Introduction: Patellar crepitus (PC) has been reported in 13% of cruciatesubstituting total knee arthroplasty (TKA) patients resulting from synovial tissue impingement within the femoral component intercondylar box (IB). Patient factors, component design, and technical errors have been implicated in PC. We compared primary TKA patients with PC requiring surgery against matched controls to identify significant variables.

Methods: The databases of 2 institutions were reviewed to identify patients requiring surgery for PC. A control group matched for age, sex, and BMI was identified. Patient charts and radiographs were reviewed. Statistical analysis was performed. Significant variables associated with patient anatomy, implant size and alignment were subsequently investigated in a computational model to evaluate tendofemoral contact.

Results: Between 2002 and 2008, over 4000 primary TKAs were performed using the Press Fit Condylar Sigma (DePuy, Warsaw, Indiana) TKA. Of these, 59 knees developed PC requiring surgery. The mean time to presentation was 10.9 months. The incidence of PC correlated with greater number of previous surgeries (1.18 vs. 0.44, p=0.002), decreased patellar button size (35.7 vs. 37.1mm, p=0.003), shorter patellar tendon length (54.5 vs. 57.9mm, p=0.01), and increase in posterior femoral condylar offset (1.27mm vs. 0.17mm, p=0.022). Using a patellar component of 32 or 35mm significantly increased the risk of PC compared to the use of a 38 or 41mm component (p<0.01, RR=1.61, OR 2.63). Modeling results demonstrated decreased patellar tendon length created increased tendofemoral contact near the IB, while larger buttons increased separation between the tendon and the box edge.

Conclusion: Shortened patellar tendon length and use of smaller patellar components may expose the quadriceps tendon to increased irritation as it traverses across the femoral component IB. Increasing posterior femoral offset may increase quadriceps tendon tension, further risking synovial tissue impingement within the IB.
INFLUENCE OF THE CRUCIATE LIGAMENTS EXCISION ON THE DYNAMIC GAP KINEMATICS: A CADAVERIC MODEL
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Routinely in TKA, at least one of the cruciate ligaments are sacrificed. The cruciate ligaments excision may have an impact in the stability of the reconstructed knee by virtue of the impact on the gap kinematics. In this study, a selective cutting protocol was designed to quantify the individual contribution of ACL and PCL about the knee by means of a loaded cadaveric model.

Five fresh frozen normal cadaver specimens were used. The femur was fixed to a specially designed machine, and 3D tibial movements relative to the femur and joint gap distances were measured by means of a navigation system from full extension to 140° flexion. The joint was distracted with 10 pounds. The measurement was performed before and after ACL and PCL excision.

Medial gap distance at 90° flexion before and after cruciate ligaments excision was 4.3 ± 2.7 mm (mean ± SD) and 5.1 ± 2.8 mm (p<0.05) respectively. Cruciate ligaments excision significantly widened the medial and lateral gaps at many flexion angles, and the effect of excision on the gap distance was different between medial and lateral sides especially at 90° knee flexion. Cruciate ligaments excision also significantly influenced knee kinematics. If this varying gap is not accounted for either through implant shape and orientation or through soft tissue adjustments, instability could be the result. Surgeons should be made aware of the influence of cruciate excision on varus/valgus laxity throughout the range of motion. Design modification of the femoral component may also be necessary in order to obtain optimal stability in deep flexion.
Stability in TKR is provided by the prosthesis design, weight bearing, alignment and soft tissue envelope which triggers proprioception and neuromuscular control. For long survivorship, the least constrained design are prefered whenever possible. Today there is a discussion about the best prosthetic femoro-tibial alignment as discussed widely in Europe and more recently by Pagnano.

Total knee replacements must be very stable to improve the function and the wear. We certainly performed too many releases in the past and misunderstood some of the fine tuning between posterior structures and collateral ligament frame. Technique in release tends to be more elaborated in order to address sequentially primary and secondary restraints. Release of the lateral structures often created excessive laxity in the past and can be addressed with translocation of the ligaments insertions.

In case of elongated collateral structures, preserving the posterior cruciate and reconstruction of the collateral ligament allows use of less constrained prosthesis. In revision arthroplasty, the condition may be even more complex but usually the collateral ligaments may be identified. It is usually possible to find and reconstruct their insertions especially on the femoral side. Sometimes, augmentation will be needed but at the end, there is a good functional collateral ligament frame.

Deformities with different soft tissues conditions and with extraarticular components in primary and revision total knee arthroplasty will be reported in severe varus, valgus and stiff knees.
DEEP VENOUS THROMBOSIS AND PULMONARY EMBOLISM FOLLOWING TOTAL JOINT ARTHROPLASTY IN HIGH RISK PATIENTS
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Patients with a thrombotic history are thought to be at greater risk for developing blood clots following total hip arthroplasty (THA) or total knee arthroplasty (TKA). The incidence of venous thromboembolism and risk factors associated with clot development in this population of patients, however, are not well defined.

From the years 2002 to 2008, 547 patients undergoing elective joint arthroplasty with a history of thrombotic disease, defined by prior history of deep venous thrombosis (DVT) or pulmonary embolism (PE), were followed prospectively for a minimum of one month after TKA or THA. Patients received prophylactic anticoagulation with coumadin starting on POD 1 with or without bridge therapy with low molecular weight heparin (LMWH). Patients were compared for the following risk factors: advanced age (>70 years old), inherited or acquired thrombophilia, time elapsed since prior episode, association of prior episode with surgery, and method of anticoagulation.

Of the 547 patients, 72 (13.2%) developed symptoms consistent with DVT or PE. Thirty-two thromboembolic events (5.9%, 26 DVT, 6 PE) were confirmed by lower extremity Doppler ultrasound, spiral computerized tomography or ventilation-perfusion scanning. 60% of events occurred before POD 3, and the average INR at the time of diagnosis was 1.67. The incidence of thromboembolism was 14.6% and 9.9% for unilateral TKA and THA, respectively and 27.6% and 25% for bilateral TKA and THA, respectively. The institutional rate of DVT during that same time frame is 1.9%. History of inherited or acquired thrombophilia (p<0.01), time elapse since prior thromboembolic event (p=0.04), and association of prior events with surgery (p=0.02) significantly increase the risk of thromboembolism in this population. Bridge therapy with LMWH of any dose did not significantly reduce the risk of DVT or PE, however, there was a trend towards significance (p=0.17). Eight patients (1.5%) experienced bleeding complications; 6 were major in nature (gastrointestinal bleeding and joint hematoma).

Patients with a thrombotic history are at increased risk for developing DVTs after joint arthroplasty. These patients share the same risk factors for development of DVT or PE then patients without a history of prior events. Furthermore, thromboembolic events tend to occur early following surgery in these patients and treatment with LMWH may help reduce the risk of developing clots when used in combination with coumadin.
Objectives: To evaluate the outcome of a cementless, low carbon MOM (metal on metal) THR with a 28mm ball-head (PPF STRATEC-SYNTHES, since 2002 BIOMET) and the concentration of metal ions within the intra-articular fluid.

Methods: 173 unilateral MOM THR’s performed in 1995 were investigated. Average follow up time was 12 yrs (range 9-14yrs). During the study period there were, 11(6.4%) deaths, 2 (1.2%) lost to F.U. and 5 (2.9%) refused follow up x-rays because of lack of symptoms, and a self perceived perception that these were not necessary. 41 effusions in part of this group could be analysed for levels of Co, Cr and Ni.

Results: 112 THR’s (64.7%) were completely symptom free and did not show any signs of osteolysis. 7 THR’s had revision surgery, unrelated to metallosis (1 cup loosening, 1 early infection and 5 late infections that could be attributed to a large amount of necrotic tissue within the joint space). 36 hips (20.8%) showed over time, progressive signs of a metallosis. Clinically none or moderate complaints in the groin were reported, and massive effusions of up to 90ml were present. The osteolysis began in the majority of these cases in the periosteal region of the acetabulum and the trochanter. No loosening of the implants was seen. A quarter of these implants had late dislocations. The CRP was up to three times above normal levels. Only 26 patients (15.0%) could be convinced to undergo further surgery (synovectomy, exchange of head and liner and bone grafting as required). Typical histology showed massive necrosis within the joint and a perivascular infiltrate of CD-3 pos. activated T-lymphocytes and L26 pos. B-lymphocytes. These findings have been recently published as ALVAL. In the 41 joint effusions, the mean level of Co was 595.6 μg/l (max 4802.2), Cr 481.1 μg/l (max 4602.9) and Ni 3.7 μg/l (max 14.4). The serum ion levels were up to four times the maximal permitted level (Co 3 μg/l, Cr 3 μg/l, Ni 3 μg/l).

Conclusion: High levels of toxic metal ions in the joint space over time can lead to a severe allergic reaction and tissue necrosis. The current literature reports, that almost all MOM bearings show slightly elevated serum metal ion levels, and therefore a much higher concentration must be calculated within the joint space. In our experience, because of the serious consequences and unpredictable onset of metallosis, we no longer use MOM articulations.
We aimed to analyze the clinical results of the patients according to joint line change who underwent navigation assisted cruciate ligament retention type mobile bearing total knee arthroplasty.

From September 2004 to January 2006, cruciate ligament retention type mobile bearing total knee arthroplasties using navigation system(Orthopilot®, Aesculap) were performed for 50 knees in 45 patients (2 men, 43 women). The mean follow up period was 46(39~55) months and the mean age was 65. There was one case with rheumatoid arthritis and all other were degenerative arthritic cases. All surgeries were performed using navigation system. Proximal tibia resection was performed at the sclerotic level of medial tibial plateau. The distance from the lowest point of lateral tibial plateau (registered point) to the proximal resection plane was measured. Clinical outcome were compared between joint line elevation with more than 3 mm(20cases) and less than 3mm (30cases).

The mean joint line elevation was 1.93 mm (range -1~5mm). There were no significant difference in the clinical results according to the joint line change (p>0.05). It may be suggested that the change of joint line in the range of -1 to 5mm in cruciate ligament retention type mobile bearing total knee arthroplasty result in satisfactory clinical outcome.
ADVANCED MICROSCOPY OF ALUMINA-ON-ALUMINA HIP PROSTHESSES: IN VIVO AND IN VITRO
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Retrieved alumina-on-alumina hip joints frequently exhibit a localised region of high wear, commonly called ‘stripe wear’. This ‘stripe wear’ can be replicated in vitro by the introduction of micro-separation, where the joint contact shifts laterally reproducing edge loading during the simulated walking cycle. While the origin of stripe wear is clearly associated with the micro-scale impact resulting from micro-separation, the wear processes leading to its formation and the wear mechanisms elsewhere on the joint are not so well understood. The purpose of this study was to compare the surface microstructure of in vivo and in vitro alumina hip prostheses, and investigate the origins of the damage accumulation mechanisms that lead to prosthetic failure.

The in vivo alumina hip prosthesis was Biolox (CeramTec, AG, Plochingen, Gemany) implanted for 11 years [1]. The in vitro alumina hip prosthesis was Biolox-forte (CeramTec, AG, Plochingen, Gemany), which had been tested in a hip joint simulator under micro-separation at Leeds University using the procedures given in [2]. The worn surfaces of the alumina hip prostheses were investigated using a Scanning Electron Microscopy (SEM). Focused ion beam (FIB) microscopy was used to determine the sub-surface damage across the stripe wear. Samples were subsequently removed for Transmission Electron Microscopy (TEM). Sub-surface damage was found to be limited to a few μm beneath the surface; ~ 2μm for in vivo samples and ~1μm for in vitro samples. The transition from mild wear to more severe (stripe) wear was entirely triggered by intergranular fracture. The first stages of fracture lead to the liberation of surface grains which act as 3rd body abrasives. The TEM showed that abrasive grooves are associated with extensive surface dislocation activity, which leads to further grain boundary fracture. This allows the cycle to be repeated and accelerated, thus yielding the stripe wear region.

The conclusions are: 1. In vitro hip simulation with micro-separation can produce similar microstructure to in vivo alumina hip prostheses; 2. To extend the life of the joint through the avoidance of severe wear, material and design solutions can be investigated using ceramic materials that have an increased surface inter-granular fracture toughness and component designs with reduced contact stress under edge loading.

Reference:
EARLY CLINICAL RESULTS OF MOBILE-BEARING REVISION TOTAL KNEE ARTHROPLASTY
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Introduction: Common failure modes of revision total knee arthroplasty (TKA) include aseptic component loosening and damage to constraining mechanisms which are often required in revision TKA. Mobile-bearing (MB) revision TKA components have been developed in hopes of lessening these failure mechanisms. Our objective was to evaluate the early clinical outcomes for the use of MB in revision TKA with a minimum 2-year follow-up and to evaluate bearing complications.

Methods: Retrospective clinical and radiographic evaluation of 84 MB revision TKAs with minimum 2-year follow-up was performed. Revision TKAs were performed using PFC Sigma and LCS revision rotating platform implants (Depuy, Warsaw, IN). Indications for revision include aseptic loosening (31 knees), instability (30 knees), failed unicompartmental knee replacement (8 knees), infection reimplantation (7 knees), arthrofibrosis (3 knees), chronic hemarthrosis (3 knees), failed patellofemoral replacements (1 knees), and nonunion of a supracondylar femur fracture (1 knee).

Results: At a mean follow-up of 3.7 years, the average Knee Society clinical and function scores had increased from 50.3 points preoperatively to 89.1 points and from 49.3 points to 80.1 points, respectively. Average motion improved from 99.8° preoperatively to 116.5° postoperatively. Radiographic review demonstrated excellent fixation with no evidence of component loosening upon latest follow-up. No cases of bearing instability were observed.

Conclusion: This evaluation of 84 MB revision TKAs has demonstrated favorable early results at a mean follow-up of 3.7 years with no occurrence of bearing instability. Longer follow-up is required to evaluate for potential advantages of reducing polyethylene wear, lessening fixation stresses, and protection of constraining mechanisms.
REVISION TOTAL HIP ARTHROPLASTY WITH A MODULAR TAPERED DISTAL FIXATION STEM: A FIVE TO TEN-YEAR FOLLOW-UP
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As the proximal femoral bone is generally compromised in failed hip arthroplasty, achievement of solid fixation with a new component can be technically demanding. Recent studies have demonstrated good short-term clinical results after revision total hip arthroplasty using modular distal fixation stems, but, to our knowledge, none have included clinical follow-up of greater than 5 years. The purpose of this study was to report the clinical and radiographic outcomes assessed 5 to 10 years following revision total hip arthroplasty with a modular tapered distal fixation stem.

We retrospectively evaluated 50 revision total hip arthroplasties performed using a modular tapered distal fixation stem between December 1998 and November 2003. There were 15 men (16 hips) and 34 women (34 hips) with a mean age of 59 years (range, 36 to 80 years). The index operation was the first femoral revision for 46 hips, the second for 3 hips, and the fifth for 1 hip. According to the Paprosky classification, 5 femoral defects were Type II, 31 were Type IIIA, and 14 were Type IIIB. An extended trochanteric osteotomy was carried out in 24 (48%) of the 50 hips. Patients were followed both clinically and radiographically for a mean of 7.2 years.

The mean Harris hip score improved from 54 points preoperatively to 94 points at the time of the latest follow-up. The mean stem subsidence was 1.5 mm. Three stems subsided more than 5 mm, but all have stabilized in their new positions. During follow-up, a total of 4 hips required additional surgery. One hip had two-stage re-revision due to deep infection, one had liner and head exchange for alumina ceramic head fracture, and the other two underwent isolated cup re-revision because of aseptic cup loosening and recurrent dislocation, respectively. No repeat revision was performed due to aseptic loosening of the femoral component. Complications included 6% intraoperative fractures, 4% cortical perforations, and 4% dislocations. There were no stem fractures at the modular junction.

The medium-term clinical results and mechanical stability obtained with this modular tapered distal fixation stem were excellent in these challenging revision situations with femoral bone defects.
Mobile-bearing (MB) total knee prostheses have been developed to achieve lower contact stress and higher conformity than fixed-bearing total knee prostheses. However, little is known about the in vivo kinematics of MB prostheses especially about the motion of polyethylene insert (PE). And the in vivo motion of PE during squat motion has not been clarified. The objective of this study is to clarify the in vivo motion of MB total knee arthroplasty including PE during squat motion. Patients and methods: We investigated the in vivo knee kinematics of 11 knees (10 patients) implanted with PFC-Sigma RPF (DePuy). Under fluoroscopic surveillance, each patient did a weight-bearing deep knee bending motion. And motion between each component was analyzed using two- to three-dimensional registration technique, which uses computer-assisted design (CAD) models to reproduce the spatial position of the femoral, tibial components, and PE (implanted with four tantalum beads intra-operatively) from single-view fluoroscopic images. We evaluated the range of motion between the femoral and tibial components, axial rotation between the femoral component and PE, the femoral and tibial component, and the PE and tibial component, and AP translation of the nearest point between the femoral and tibial component and between the femoral component and PE.

Results: The mean range of hyper-extension was 2.1° and the mean range of flexion of 121.2°. The femoral component relative to the tibial component demonstrated 10.4° external rotation for 0-120 degrees flexion. The tibial component rotated 10.2° externally relative to the PE and the femoral component minimally rotated relative to the PE within ± 5 degrees. In upright standing position, the femoral component already rotated externally relative to the tibial component in 6.3°, and the PE also rotated on average 6.4° externally on the tibial tray. Typically the femoral component relative to the tibial component exhibited a central pivot pattern external rotation from extension to 80° knee flexion. Subsequently from 80 to 120°, bilateral condyles moved backward. In a similar fashion, the femoral component relative to the PE exhibited a central pivot pattern external rotation from extension to 70° knee flexion and subsequently bicondylar rollback from 70 to 120° knee flexion.

Discussion and conclusion: In this study, we evaluated the in vivo motion of PE during squat motion. About this total knee prosthesis, the mobile-bearing mechanism which advantages over fixed-bearing prosthesis to reduce contact stress and keep high conformity might work well, and arc of range of motion was maintained. Furthermore, in upright standing position, the femoral component and tibial component already rotated externally relative to the PE in almost equal measure. This indicated that, self-aligning mechanism, another characteristic of the MB prosthesis might also work well.
BIOACTIVE BONE CEMENTS CONTAINING MICRON-SIZED TITANIA PARTICLES

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Many types of bioactive bone cement have been developed to overcome the disadvantages of polymethylmethacrylate (PMMA) bone cement, especially its lack of bone-bonding ability, which occasionally leads to aseptic loosening of prostheses used for arthroplasty. Earlier, we showed that bioactive bone cements containing either nano-sized or micron-sized titania (TiO₂) particles had excellent in vivo osteoconductivity. However, anatase phase titania particles contained in these bioactive bone cements raise concerns about their safety in vivo. We developed pure rutile micron-sized titania particles. because rutile is the only stable phase, whereas anatase is metastable.

In this study, polymethylmethacrylate (PMMA)-based bone cement containing pure rutile micron-sized titania (TiO₂) particles were developed, and their mechanical properties and osteoconductivity are evaluated. The three types of bioactive bone cement were T10, T20, and T30, which contained 10, 20, and 30wt% TiO₂, respectively. Commercially available PMMA cement (PMMAc) was used as a control. Hardened cylindrical cement sample (φ2.5mm*10mm) was inserted manually on rabbit femur vertically. Push out test was performed for evaluation of bonding strength. For mechanical testing, the flexural strength, flexural modulus, and compressive strength were measured.

Results of this study revealed that polymethylmethacrylate (PMMA)-based bone cement containing pure rutile micron-sized titania particles has outstanding osteoconductivity in vivo, and their mechanical properties were exceeded that of commercially available PMMA cement. Interfacial shear strength of T10, T20 and T30 were 17.1~24.0MPa each at 12 weeks, and were significantly higher than PMMAc. In general, the interfacial bonding strength of bone cement depends mainly on its interdigitation with cancellous tissue, which is accomplished by the pressurized injection of the cement in paste form. On the other hand, we inserted the hardened specimens into oversized holes on rabbit femur in this study, because we intended to examine the osteoconductive and bone-bonding potentials of each material. The flexural strength, flexural modulus, and compressive strength were equivalent to or exceeded that of PMMAc.

These results show that bone cement containing pure rutile micron-sized titania particles is a promising material applied to prosthesis fixation as well as vertebroplasty.
IMPROVING THE ACCURACY OF ACETABULAR COMPONENT ORIENTATION: TECHNIQUES TO AVOID MALPOSITION

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Many factors can negatively impact acetabular component positioning including poor visualization, increased patient size, inaccuracies of mechanical guides, and inconsistent precision of conventional instruments and techniques, and changes in patient positioning. Improper orientation contributes to increased dislocation rates, leg length discrepancies, altered hip biomechanics, component impingement, acetabular component migration, bearing surface wear, and pelvic osteolysis thus affecting revision rates and long-term survivorship. Despite the established definitions of acetabular safe zones, recent analysis of U.S. Medicare THA data found dislocation rates during the first six months to be 3.9% for primary surgeries and 14.4% for revision surgeries. Accurate and precise acetabular component orientation during initial THA is an increasingly important factor in decreasing revision THA; a recent report cites instability and dislocation as the primary cause of revision accounting for 22.5% of cases. Larger femoral heads and alternative bearing couples are less tolerant of variation in acetabular orientation and thus are poor substitutes for proper acetabular component placement.

Variability in acetabular orientation has been reported to have both an inter-surgeon and an intra-surgeon component; pre-surgical templating combined with intraoperative measurements is subject to inconsistencies and errors. Current methods for determining acetabular orientation include preoperative imaging such as CT scans, intraoperative imaging such as plain radiographs and fluoroscopy, and intraoperative anatomical tests. Combining the concepts of patient-specific morphology (PSM) and quantitative technologies (QuanTech) such as computer-assisted navigation (CAN) has the potential to maximise range of motion and to further improve acetabular component orientation through improved accuracy and precision.

PSM refers to the practice of allowing the form and structure of the patient’s hip joint to guide surgical reconstruction and component placement thus creating an individualised and more accurate “target zone”; unlike “safe zones,” PSM does not rely on averages. Although gross anatomic changes may make it difficult to use PSM, certain structures may be used as guideposts for orientation, alignment, and stability in most patients. At present, there are three options when considering anatomic landmarks as guides for acetabular component placement: bony landmarks, soft tissue landmarks, or a combination.

QuanTech has been shown to increase the precision of component placement by reducing intra-surgeon deviation. Some pitfalls of current CAN techniques result from maintaining camera line of sight during surgery, registration process, and pin placement. Performing THA using smaller incisions can impose additional complications as well as risks for errors in component positioning; QuanTech has the potential to provide greater visualization and precision, thus decreasing the impact of those constraints.

THA has become one of the most common and successful orthopaedic procedures; its efficacy at relieving pain and its ability to help patients have improved quality of life is without dispute yet results continue to vary with inter-surgeon and intra-surgeon differences. As the population needing THA increases, the prevalence of complications and problems will increase, even if the percentage of complications decreases. Coupling PSM with QuanTech such as CAN may allow the surgeon to decrease variability and more consistently implant THA components based on each patient’s individualized requirements. The goal of combining PSM and CAN is to further reduce inter- and intra-surgeon variation, thereby decreasing outliers, complications, and revision rates, and possibly narrowing the gap between specialist and generalist. More accurate and precise acetabular component orientation correlates with better hip biomechanics, translating into better function, fewer dislocations, fewer impingements, maximized safe range of motion, less wear, and therefore less aseptic loosening and improvements in survivorship of primary THA. Decreasing revision rates, combined with the benefits listed above, could translate into increased THA survivorship, improved patient satisfaction, and decreased economic burden on the entire healthcare system.
Pre-clinical Evaluation of Total Knee Designs for Restoring Normal Knee Mechanics

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The objective was to develop a simple, rapid, and low-cost method for evaluating proposed new Total Knee (TKA) designs, and then to use the method to evaluate three different TKA models with different kinematic characteristics. In a previous study, we reported on the use of an Up-and-Down Crouching Machine, where the neutral path of motion for knee specimens were measured, and then TKR models were implanted and the tests repeated. These experiments showed that standard CR and PS designs behaved more like an ACL deficient knee, whereas Guided Motion knees produced motion similar to that of the intact specimens. However the method was time consuming, technically demanding, and expensive, and hence is suitable for designs which had already passed through a screening method. The latter was the subject of this present study, called the Desktop TKR Test Machine.

The principle of the testing protocol on the machine, called Holistic Testing, was that a spectrum of compressive, shear and torque forces were applied to a knee, to represent a complete spectrum of daily and sporting activities. The resulting femoraltibial positions were measured, both the Neutral Path of Motion and the Laxity about the neutral path. The motions were displayed as both the motion of the transverse femoral axis on the tibial surface, and by the centers of the lateral and medial contact patches. Eight knee specimens were tested first, to act as a reference target for evaluating TKR models. Knee models were designed in the computer and made in a hard low-friction plastic using SLA and stereolithography.

A typical Posterior-Stabilized (PS) TKA did not display the normal external femoral rotation with flexion, and also showed abnormal anterior sliding on the medial side prior to cam-post engagement. Guided Motion designs included a Medial Pivot type, and a Medial Pivot with a cam-post. Both of these had a dished medial side and a shallow lateral side, to more accurately reproduce anatomic motion characteristics. The guided motion design with the cam-post produced a neutral path and laxity more similar to that of normal.

It was concluded that the test method satisfied the objective in terms of being a useful test method for rapid evaluation of new proposed TKR designs. The method was able to identify designs which showed motion and stability characteristics closer to the normal anatomic knee.
TIMING OF SYMPTOMATIC PULMONARY EMBOLI FOLLOWING TOTAL HIP AND TOTAL KNEE ARTHROPLASTY. ARE WE AIMING AT THE WRONG TARGET?
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The focus of deep vein thrombosis (DVT) prophylaxis following total joint arthroplasty has shifted in recent years to the reduction of symptomatic pulmonary emboli (PE). The relative infrequency and presumed delayed occurrence of these events has led many to suggest that the risks of more frequent early postoperative complications of treatment, especially bleeding, be weighed against the benefits of thromboembolic prophylaxis. The purpose of this study was to determine the timing and risk factors associated with the development of symptomatic PE following total hip arthroplasty (THA) and total knee arthroplasty (TKA).

A retrospective analysis was performed of all patients diagnosed with a symptomatic pulmonary embolism following THA and TKA performed from January, 2004 to March, 2008. The records of 4706 patients were reviewed who were operated upon by 7 surgeons, and a total of 58 PE were identified. All patients were managed and treated by an anti-coagulation dosing service. Helical CT Scans were used to make the diagnosis of PE.

The overall incidence of PE was 1.2%, with 1.8% occurring in TKAs and 0.5% occurring in THAs. 48 of the 58 PE patients (83%) were women. 33 patients (57%) had unilateral TKA, 14 (24%) had bilateral TKA and 11 (19%) had THA. The average patient age was 65 (range: 44-88) and BMI was 33.8 (range: 24.7-51.9). There was no apparent correlation between age and BMI with incidence of PE. The PE were diagnosed an average of 4 days (range: 1-46) following surgery. 56 of the 58 patients (97%) were diagnosed by the sixth postoperative day. The average INR at the time of diagnosis was 1.7 (range: 1.0-3.0). There were two mortalities (3%), both of which occurred within the first two postoperative days.

The PE in this study occurred predominantly in women undergoing TKA. There appears to be an urgent need to develop an effective prophylaxis program aimed at preventing PE in the early post-operative period and to identify patients at risk of these PE.
This study aims to compare the gait pattern of patients operated with a TKA versus a normal population in order to evaluate if the excellent function of TKA reported in the literature corresponds to objectively measured parameters.

20 patients operated of TKA with a follow up > 1 year, all patients rated with a very good functional result (Knee Society Knee score > 85/100 – VAS <= 1/10) were compared with a group of 20 “normal” persons.

The study was blind: the examiner did not know whether the person was a normal, or which knee was operated.

The test consisted in an 11 meters walk, on an AMTI force platform; the movements of the body were recorded with 6 IR cameras and analysed with the “Motion Analysis” software. The implant was a mobile bearing AP stabilised knee.

The measured parameters were kinematic: speed, step length, flexion angle, duration of stance/WB phase and dynamic: flexion/extension, varus/valgus, internal/external moments and resultant force direction. When matched with age and BMI, all kinematic parameters of the TKA group are equal to that of the normals.

However, dynamic parameters differ significantly between both groups:

At the end of stance phase and heel strike the operated patients have a lack of extension of 10° despite a clinical measurement of full extension (0°) In the frontal plane, all patients exhibited a valgus walking pattern but the mechanical axis measured on long standing radiographs was 180° +/- 1°. In the horizontal plane, all operated patients had an external rotation of +8° compared to the normals.

Despite excellent clinical scores and radiologic positioning, gait analysis demonstrates important dynamic differences between the TKA and the normal group. The extension lag at heel strike may be related to either quad weakness, or an insufficient extension gap at surgery; The valgus resultant pattern occurs despite a perfect alignment of the mechanical axis (180°) on the operated patients: this rises the question whether this alignment is the goal or if an undercorrection would be more physiologic. External rotation is superior to the normal group: it is in relation with the external rotation of the femoral and tibial components.

Conclusion. Gait analysis of the TKA group of patients compared to normal demonstrates important dynamic differences in relation with the surgical positioning of the implant.
ASSESSMENT OF DISCREPANCY BETWEEN IMAGE-FREE NAVIGATED ACETABULAR CUP ORIENTATION AND 3-DIMENSIONAL RECONSTRUCTED CT-BASED MEASUREMENTS IN ASIAN PATIENTS

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Background: The purpose of this prospective study was to assess the reliability of image-free navigated cup positioning and its correlation with biometrical parameters (age, sex, body mass index, soft tissue thickness overlying anterior superior iliac spine and symphysis pubis, and lumbar lordosis) and three different orientations of pelvis (tilt, obliquity, and rotation) in patients of Asian ethnicity.

Methods: Intraoperative data was obtained from 50 consecutive total hip arthroplasties in which acetabular cup implantation was done with a cementless cup (Plasma Cup SC®, Aesculap AG, Tuttlingen, Germany) using Orthopilot® image-free navigation system. The data was then compared with mathematically calculated synchronized anteversion and inclination obtained postoperatively through computed tomography and 3-dimensional processing.

Results: Mean navigated and synchronized inclination obtained were 40.1°±5.34° and 41.79°± 7.96° respectively (mean difference 1.69°±6.95°, range -20.72° ~ 18.47°), while the mean navigated and synchronized anteversion were 19.98°± 6.44° and 20.00°± 6.33° (mean difference 0.01°±6.35°, range -15.15° ~ 11.10°). A discrepancy of > 10° was observed in 5 hips in inclination and 5 hips in anteversion. No correlation was found between all of biometrical parameters and discrepancy of cup orientation. A statistically significant correlation was found between discrepancy of anteversion and pelvic tilt (1.78 + 0.55 x pelvic tilt°, r=0.493, p=0.0016).

Conclusion: In spite of variations in pelvic geometry, image-free navigation assisted acetabular cup positioning showed the significant reliability. The next generation of navigation systems must be combined with data on precision of pelvic orientation intraoperatively for complete validation.

*Index; Synchronized Inclination = arctan [tan (Operative AV) ÷ tan (Anatomic AV)]
Synchronized AV = arctan[tan (Anatomic AV) x sin (synchronized Inclination)]
or arctan[tan (Operative AV) x cos (Synchronized Inclination)
SHOULD THE ‘NO THUMB TECHNIQUE’ BE THE GOLDEN STANDARD FOR EVALUATING PATELLAR TRACKING IN TOTAL KNEE ARTHROPLASTY?
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We checked intraoperative patellar tracking with both ‘towel clip technique’ and the ‘no thumb technique’ on 354 patients (571 knees) who underwent primary total knee arthroplasty to decide whether to do or not to do lateral retinacular release.

All surgical procedures consisted of medial parapatellar arthrotomy and patellar resurfacing. Patellar tracking was assessed under pneumatic tourniquette with the no thumb technique first and reevaluated with the towel clip technique. The tracking was graded as total contact, good contact, lateral contact, and subluxation. The knees graded as total or good contact with the no thumb technique were classified into group A; those graded lateral contact or subluxation by the no thumb technique but total or good contact by the towel clip technique were classified into group B; and those graded lateral contact or subluxation by both techniques were classified into group C, in which lateral releases were performed. We classified 371, 148, and 52 knees into groups A, B, and C respectively. Patellar lateral tilting in the Merchant view was reviewed preoperatively and 2 weeks, 6 weeks, 6 months, and 1 year postoperatively.

There were no statistical differences on postoperative patellar tilting among the groups. Assessment of the patellar tracking using only the no thumb technique may overestimate the need for lateral retinacular release. The use of the no thumb technique as a screening test, and reevaluation with the towel clip technique, may reduce unnecessary lateral retinacular release.
STRAIGHT CEMENTLESS STEM IN THA: 196 PATIENTS FOLLOWED FOR 10-12 YRS
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Background: Poor results were observed at medium term follow-up (FU) after first and second generation cementless stems implantation in total hip arthroplasty (THA). Revision rate up to 24% is reported with anatomic stems; stress-shielding rate up to 50%, thigh pain rate up to 21%, loosening rate up to 20% and osteolysis rate up to 29% were reported with cylindrical stems. A third generation tapered stem, the Synergy stem, was introduced in 1996 to rise such weakness points.

Material and methods: A retrospective, cohort study was carried out in two academic centers (London, Toronto, Canada & Rome, Italy) on 232 primary THA in 215 patients with a 10 to 12 yrs FU. Mean age at surgery was 60 yrs (18-82), 95 patients were males and 120 females. Thirty-six patients were lost at FU (13 died before the 10 yrs mark, 22 changed residency, 1 not willing to be seen) with no problems related to the replaced hip. Remained at FU 196 THA. Patients selection: Dorr type A and B femurs suitable for receive a Synergy stem. Its characteristics are the following: Ti-6Al-4V, straight, tapered, 3D wedge cross-section, proximal antirotational fins, low-profile neck, neck angle 131°, metaphyseal part porous or HA coated, diaphyseal part grit blasted, polished tip, surgeon-friendly ancillary instruments. Clinical results of the 196 THA with more than 10 yrs of FU were assessed preoperatively and postoperatively at 5 and 10 or 11 or 12 yrs by means of standard evaluation tools: SF12, WOMAC and Harris Hip Score. Thigh pain frequency and intensity were also scored. Radiographic analysis was focused on stem alignment, bone ingrowth, radiolucent lines presence, width and progression, stress-shielding, heterotrophic ossification (HTO). Student paired test and Kaplan-Meier survival analysis were used for statistical analysis.

Results: All clinical evaluation tools showed both at 5 years FU and at latest FU (10-12 years) a statistically significant (p=0,001) improvement compared to the preoperative scores. We observed a not constant thigh pain in 7 patients (5,5%). Nineteen patients (10%) underwent revision due to polyethylene wear (6 cases), late periprosthetic fracture (5 cases), subsidence (2 cases), instability (3 cases), infection (3 cases). Cumulative survival rate was 97% at 2 and 5 years, 90% at 10 years. Stem related revisions were the 2 cases of subsidence, both related to occult intraoperative calcar crack and early revised (within 1 year); cumulative stem-related survival rate at 10 years was 99%. Alignment was varus in 9 cases and valgus in 3. Bone ingrowth was observed in 194 patients (98%). Radiolucent lines were uncommon, non progressive, less than 2 mm, in Gruen zones 2 and 6. Stress-shielding was present as cortical reaction in 5 femurs in Gruen zones 3 and 5. Thirty-four cases of HTO (grade I and II in 27 case and grade III in 7 cases) were observed.

Conclusions: The Synergy stem demonstrates excellent clinical and radiographic results at 10-12 years FU in 196 patients. Survivorship (with stem revision as end point) is 99% at 10 years. Thigh pain is uncommon and the level of activity and autonomy is excellent. Radiographically bone ingrowth is evident in all stems and radiolucent lines are “benign” with no aseptic loosening. Attention must be paid at the moment of stem press fit insertion to avoid occult proximal femoral fractures that may require revision surgery.
A consensus on total hip arthroplasty (THA) concluded that the major remaining issues of concern included the long-term fixation of the joint replacement, osteolysis due to polyethylene (PE) wear debris which often leads to aseptic loosening. Alumina ceramics had been extensively used in medicine, and we started using the alumina ceramic for THA bearing surface in hopes to reduce the PE debris. It was because alumina ceramics is advantageous for precision machining compared with metal materials, and its hardness is higher than that of metal materials. Also, to augment cement–bone bonding, we interposed hydroxyl apatite (HA) granules at the cement–bone interface, so called “Interface Bioactive Bone Cement (IBBC) technique”. HA granules (2–3 g) were smeared on the bone surface of the acetabulum and femur just before cementing. In this study, we evaluated 19–22 years clinical results of THA with alumina ceramic head combined with PE cup fixated IBBC technique.

Total 285 joints (212 patients) were implanted by one senior surgeon from January 1986 to December 1988, and 265 joints (192 patients) were traceable. Alumina ceramic femoral head of 28 mm in diameter and acetabular cup of the conventional PE sterilized with ethylene oxide gas were used in all patients. The PE cup and stem were fixed with IBBC technique in all cases. The presence of radiolucent line, loosening and osteolysis were observed using radiograph of the traceable cases. The locations of radiolucent lines were identified according to the zones described by DeLee and Charnley for acetabular cups and the zones described by Gruen et al. for femoral stems. The in vivo wear of 21 PE acetabular cups for 19.0–21.9 years (mean 20.3 years) was measured from the latest radiographs using computer assistant technique with Vector Works 10.5 software.

Features of the clinical radiograph images of the IBBC case were classified as follows: the radiolucent line represented “gap” between the HA layer and the cement; the loosening represented “opening” between the HA layer and the cement. For the quantitative analysis, we divided the surrounding bones of the THA into several zones as done in the previous studies. The “gap” appeared in zone 4 in three joints (1.4 %), in zone 3 in two joints (0.9 %) of acetabular cup. In femoral side, in zone 1 in four joints (1.8 %) in zone 7 in one joint (0.4 %). The “opening” appeared in three acetabular cup (1.4 %). Since no opening was appeared in zone 3 or zone 4, however, no re-operation was needed. Images of osteolysis were seen one in zone 1 (0.5 %), and one in zone 2 (0.5 %) in acetabular side and two in zone 1 (0.9 %) of the femur. The mean linear wear rate of PE acetabular cups was 0.13 mm/year.

The fixation to the bone by the IBBC technique has been maintained for long term. We think that the result was brought by the biological integration between bone and HA granules. In conclusion, this study has shown satisfactory results of the cemented THA with ceramic head combined with PE cup for 19–22 years.
Total knee arthroplasty (TKA) has been proven to be the most effective treatment for patients with severe or “end-stage” joint disease. Although infection is not a frequent complication of total knee arthroplasty, it is certainly one of the most dreaded. The purpose of this study was to identify related factors associated with septic arthritis.

2202 primary total knee arthroplasties were done in 1257 patients between 1995 and 2006. Of these knee arthroplasties, 2022 knees in 1146 patients were available for follow-up. Revision arthroplasty procedures and infected knees were excluded. 252 knees in 147 males, 1770 knees in 999 females were done. Their mean age at the time of primary TKA was 70.6 (range, 26-91) years. The mean follow-up period post primary TKA was 48 (range, 3-145) months. The medical records were reviewed to extract the following information: age, gender, body mass index, preoperative CRP, preoperative ESR, preoperative TP, duration of surgery, operative blood loss, total blood loss, duration of surgical drain, duration of antibiotic prophylaxis, primary diagnoses, smoking, diabetes mellitus, steroid or DMARDs therapy, previous operation around the knee joint, previous arthroscopic surgery, previous except arthroscopic surgery, previous operation of high tibial osteotomy (HTO) or open reduction internal fixation (ORIF), residue of internal fixation material, bone graft, patella replacement, and bone cement.

Proportions were compared using the chi-square or two-tailed Fisher’s exact test, as appropriate. Continuous variables were compared by the student’s t-test. Logistic regression analysis (stepwise) of selected variables from univariate analysis was performed to identify factors independently associated with the development of infection following total knee arthroplasty.

During the study period, 17 infected knee arthroplasties in 17 patients were identified. The infections occurred in 8 males and 9 females, with a medial age of 69.5 years.

The results of univariate analysis indicating those variables statistically associated with infection are: gender (p < 0.0001), smoking (p = 0.02), previous operation around the knee joint (p = 0.001), previous except arthroscopic surgery(p < 0.0001), previous operation of ORIF (p < 0.0001), residue of internal fixation material (p <0.0001).

Logistic regression analysis indicated that the four predictors of infection following total knee arthroplasty were gender (odds ratio [OR], 0.2; 95% confidence interval [CI95], 0.1 to 0.6; P=0.005), previous operation of ORIF (OR, 7.9; CI95, 1.1 to 57.1; P=0.041), residue of internal fixation material (OR, 26.0; CI95, 4.5 to 151.0; P<0.001), body mass index (OR, 1.2; CI95, 1.0 to 1.3; P=0.007).

We conclude that the risk factors of infection after TKA were previous operation of ORIF, gender, residue of internal fixation, and body mass index.
THE LEWINNECK-SACRUM ANGLE: A NEW CONCEPT TO OPTIMIZE THA PLANIFICATION AND NAVIGATION ACCORDING TO STANDING AND SITTING POSITIONS

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Introduction: Computer assisted total hip replacement (THA) usually uses the anterior pelvic plane (plane of Lewinneck, APP) for reference because the anatomical landmarks are easy to access during the surgical procedure. However, a recent study shows the lack of correlation in between the Lewinnek angle in standing position (L) and the spinal radiological parameters for sagittal balance, specifically the incidence angle and the sacral slope. The anatomical variations of the anterior superior iliac spines account for the discrepancy. The authors propose here the assessment of the Lewinnek – sacrum angle (LS) (anterior pelvic plane to the sacral endplate)

Methods: 120 asymptomatic patients with THA had low dose lateral X-rays of the lumbopelvic area (Definium 8000, GE Healthcare; dose 0.6 mSivert). The measurements of the sacral slope, incidence angle, and APP were done by two independent observers.

Results: The sacral slope and incidence angles were similar to other series. The APP was no clearly identified in 78 cases. The average L angle was -3° (SD 8°) in standing position, -23° (SD 11°) in sitting position, and -2° (SD 8°) in lying position. The average LS angle was 47° (SD 13°). The geometrical relationship between the LS angle, the L angle and the sacral slope is reported.

Conclusion: THA stability supposes that the orientation of the acetabular component shall remain within extreme values in standing, sitting, and lying postures. The adjustment of the acetabulum takes into account the functional anatomy of the lumbopelvic area. The sacral slope is a reliable radiological reference and is related to the sagittal balance of the spine. The APP presents some interindividual variability and is poorly visible on the radiographs, but it is easily accessible during surgery. The author suggest using the Lewinnek sacrum (LS) angle for radiological planification and for surgical navigation procedures.
Acetabular component malpositioning increases the risk of impingement, dislocation, and wear. The goal of computer-assisted techniques is to improve the accuracy of component positioning, in particular optimizing the orientation of the acetabular cup. The goal of the current study was to measure accuracy of cup placement in a large clinical series of hips that underwent CT-based computer-assisted THA.

146 hips in 140 patients underwent CT-based computer-assisted THA between 2006 and 2008. In all cases cup orientation was planned according to the individual preoperative CT and the anterior pelvic plane with an inclination of 41° and anteversion of 30°. For the procedure, all patients were placed in the lateral position and the cup was implanted using angled instruments. Intraoperatively all cases were navigated using an optoelectronic camera and tracked instruments (Vector Vision prototype, BrainLab, Germany).

Post-operatively, cup orientation was measured using a previously validated technique of 2D/3D-matching using the preoperative CT and post-operative radiographs. This technique allows for accurate measurement of cup position from plain radiographs corrected for individual pelvic orientation. The mean accuracy for inclination was -2.5° ± 4.0° (-12° – 10°) and for anteversion it was 0.7° ± 5.3° (-11° – 15°). In 2 hips (1.4%) a deviation of more then 10° in inclination and in 4 hips (2.7%) a deviation of more then 10° in anteversion were found.

The current study demonstrates that the acetabular component can routinely be implanted with the assistance of CT-based navigation with reasonable agreement between the navigation measurements of component orientation at the time of surgery. Nonetheless, outliers still occasionally occur. These might be due to unrecognized loosening of the pelvic reference base, inaccurate registration or the use of the ipsilateral surface-based registration algorithms which rely heavily on points near the center of rotation of the hip.
THE USE OF POROUS TANTALUM FOR BONE LOSS IN REVISION TOTAL KNEE ARTHROPLASTY: A MINIMUM TWO-YEAR FOLLOW-UP
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Bone loss is a challenging reconstructive problem in revision total knee arthroplasty (TKA). Un cemented porous tantalum modular components are designed to act as substitutes for allograft bone in complex revision TKA with significant bone defects.

A consecutive series of 23 revision TKAs performed by a single surgeon were reviewed at a minimum two-years following implantation. In all cases bone loss was assessed using the Anderson Orthopaedic Research Institute System, and porous tantalum components were used to augment the reconstructions when bone loss was encountered.

Twenty-one patients had 23 procedures (2 bilateral) requiring the use of porous tantalum following 18 cases of aseptic loosening, 4 cases of staged re-implantation for infection, and 1 case of a periprosthetic patellar fracture and aseptic loosening. Structural bone graft was not used during this time period. Porous tantalum uses include: 20 distal and posterior femoral augments; 2 femoral cones; 8 patellar augments; and 18 tibial cones. 20 cases required augmentation in more than one area, and one case involved an extensor mechanism allograft. There were 2 cases of recurrent sepsis requiring removal of well-fixed tantalum components. At an average 37 months (24 to 73) no patients were lost to follow-up. Clinical follow-up in the remaining 21 cases showed reconstructions were functioning well with no revisions. Radiographic imaging showed re-establishment of the joint line, neutral mechanical axis, and signs of stable fixation of the augments. There were no cases of radiographic or clinical loosening at the most recent follow-up.

Short term results with the use of porous tantalum augments and cones for bone loss in revision TKA demonstrate the versatile, and durable nature of these new reconstructive tools, at early follow-up.
METAPHYSEAL ENGAGING SHORT STEM FREMORAL IMPLANTS: A TWO-YEAR FOLLOW-UP
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Despite the clinical success of uncemented femoral stems of various types, current issues continue to require repeated examination: 1) proximal-distal mismatch 2) optimization of load transfer and preservation of femoral bone and 3) facilitation of MIS (minimally-invasive surgery) exposures, particularly an anterior approach. A previous study demonstrated that a custom-made (based on CT-scan) short metaphyseal engaging femoral stem design provided stable fixation and reliable bony ingrowth at four-year follow-up. The purpose of this study is to present the minimum two-year clinical and radiographic results obtained with an off-the-shelf metaphyseal filling stem.

An uncemented, metaphyseal engaging femoral stem was inserted in 194 consecutive hips in 181 patients, whose average age was 70 years (range 32-95) and BMI of 28 (range 19-63). The implant, which averaged 94 millimeters in length (range 91-105), was made of titanium alloy with a hydroxyapatite coating on a titanium plasma-spray in the third of the stem.

The average Harris hip score (HHS) was 52 (range 10-80) preoperatively and 91 (range 70-100) postoperatively and no patients experienced thigh pain. Preoperative WOMAC scores averaged 48, compared to a postoperative average of 4. There were no fractures or other complications related to the prosthesis, no radiographic evidence of subsidence, and all stems were radiographically stable on most recent radiographs. The typical pattern of bony ingrowth was that of bone bridging and endosteal condensation at the proximal portion of the stem.

This study demonstrated that the use of an off-the-shelf short femoral stem designed to fit and fill the metaphysis provides reliable clinical and radiographic results at a minimum two-year (average 31 months) follow-up. Short stems may be particularly helpful to surgeons performing total hip arthroplasty using a MIS anterior approach.
Introduction: The Direct Anterior Approach (DAA) for hip replacement is an unfamiliar approach to most surgeons. The challenging portion of this approach is the preparation of the femur. In this study we determine factors that can assist in predicting the difficulty of femoral preparation to improve the learning curve.

Methods: Data was collected prospectively on 151 consecutive cases utilizing the DAA for hip replacement. After each case the femoral preparation was rated into one of 5 categories: very easy, easy, medium, difficult and very difficult. Clinical and demographic data were collected prospectively using web based data entry software. Post-operative x-rays were evaluated by an independent reviewer unaware of the exposure difficulty. Using multivariate regression, we examined several different x-ray based pelvic measurements as predictors for difficulty of femoral exposure.

Results: Univariate analysis demonstrated difficulty of femoral preparation was significantly (p<0.05) correlated with height (OR=2.67, 95% CI = [1.03-6.94]), weight (OR=8.30, 95% CI=[2.35, 29.35]), male gender (OR=6.11, 95%CI=[1.97-18.97]), the distance from the greater-trochanter-to-ASIS (OR=0.30, 95%CI=[0.11-0.82]), teardrop-to-teardrop (OR=0.29, 95%CI=[0.11-0.79]), and greater-trochanter-to-greater-trochanter (OR=3.31, 95%CI=[1.23-8.95]). From this, we determined a simple pre-operative formula which allows the surgeon to predict difficult femoral preparations with an 87% sensitivity and easy preparations with >95% specificity.

Conclusion: In MIS hip surgery, the DAA 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. With new advances in surgical procedures, selecting the appropriate patient can reduce the risks to the patient and minimize the cost to society of integrating new surgical techniques.
TREATMENT OF THE SEQUELAE OF SLIPPED CAPITAL FEMORAL EPhipYSIS USING CUNEIFORM OSTEOTOMY OF THE FEMORAL NECK THROUGH SURGICAL HIP DISLOCATION

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Long-term functional and degenerative consequences of non treated slipped capital femoral epiphysis (SCFE), have been extensively demonstrated. At present, the treatment of SCFE is well described, however the treatment of the sequelae of SCFE, once osseous consolidation has happened, remains controversial.

Our aim is to describe an original technique of cuneiform osteotomy of the femoral neck through surgical hip dislocation for the treatment of sequelae of SCFE. Six hips were operated with sequelae of severe SCFE; average age of 15,2 years, whose consulting motivation was hip pain and severe limp. All of them, with bony consolidation of the femoral physis at the time of the consultation.

In all cases, it was performed a cuneiform osteotomy of femoral neck and replacement of the femoral epiphysis, through surgical hip dislocation. It was made a dissection and elevation of cervical periosteum to protect the epiphyseal vessels of the femoral head; then, the cuneiform osteotomy of the femoral neck is made with replacement of the femoral epiphysis to anatomical location and fixed.

The mean follow up was 21,2 months. We obtained consolidation in 100% of the cases, did not appear avascular necrosis nor other complications. An improvement was obtained according to Harris Hip Score from 37,6 points to 96,6. Correction of the epiphyseal-shaft angle was obtained from 62º to 12,6º.

This technique proposed in patients with sequel of SCFE is a good alternative of treatment, with good anatomical, functional, clinical and radiological results in young patients, without mid-term complications.
BIOLOGIC FIXATION OF AN ASYMMETRIC TITANIUM PARTICLE POROUS COATING IN A LOAD-BEARING ANIMAL MODEL


This study evaluated the biologic fixation of two different titanium porous coatings: a clinically successful sintered spherical bead coating [1] and a new sintered asymmetric particle coating (STIKTITE™, Smith & Nephew). The spherical bead coating has a porosity of about 50% and an average pore size of about 220 μm, whereas the STIKTITE coating has greater porosity (about 62%) and slightly smaller average pore size (about 200 μm). Biologic fixation was assessed using a load-bearing ovine model in which coated semi-circular disc implants were inserted into a defect created in the cancellous bone parallel to and approximately 3 mm below the medial tibial plateau [2] similar to the method reported by Ignatius [3]. The implants were slightly thicker than the defect created, producing a 0.2-mm overall press-fit. Initial implant stability was assessed using mechanical push-out (n = 3) immediately after implantation into cadaveric ovine bone. Quantitative mechanical push-out testing and qualitative histology (n = 9 and n = 2, respectively, per group per time point) was performed after six and 26 weeks in vivo.

The time-zero average peak push-out load (±S.D.) of the STIKTITE group (95±3 N) was found to be significantly greater (p < 0.02) than that of the spherical bead group (36±5 N). By six weeks in vivo, the average peak push-out load for the STIKTITE group was up to 1001±362 N, and that for the spherical bead group was up to 985±425 N, both representing a significant increase compared to their time-zero results (p < 0.0005). From six to twenty-six weeks in vivo, there was again a significant increase in the peak push-out load irrespective of group (p < 0.0005), with the average peak push-out loads up to 1620±406 N and 1444±446 N for the STIKTITE and spherical bead groups, respectively. Histology revealed bone ingrowth in both groups that confirmed the findings of the mechanical push-out testing. While the STIKTITE group showed a trend toward greater biologic fixation, overall there was insufficient evidence to support differences between the two groups (p = 0.47) irrespective of the amount of time in vivo.

The results of this study confirm the ability of the STIKTITE coating to achieve superior initial stability. This improved initial stability reduces the reliance on adjunct fixation (such as screws) or large amounts of press-fit to prevent micromotion and create an environment suitable for long-term bone ingrowth. The results also suggest that the STIKTITE coating had a tendency to initiate and maintain bone ingrowth under load-bearing conditions to a level greater than that of a clinically successful sintered bead coating. Because loading of the implant can cause micromotion at the bone/implant interface, models like the one used in this study likely provide a more challenging and realistic representation of anticipated clinical conditions than models with minimal implant loading.

References
EFFECT OF CONCOMITANT LATISSIMUS DORSI TRANSFER ON JOINT
REACTION FORCE FOR REVERSE TOTAL SHOULDER ARTHROPLASTY
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Although reverse total shoulder arthroplasty (TSA) may restore shoulder abduction and forward
flexion in the setting of a massive rotator cuff tear, the ability to use the extremity for ADL’s is
often limited by external rotation weakness. Even though the reverse TSA restores abduction, the
patient may be unable to bring the hand to his or her mouth because with the elbow flexed the
weight of the hand causes the shoulder to fall into internal rotation. Concomitant transfer of
latissimus dorsi (LDT) to the posterior greater tuberosity is a solution advocated by some
surgeons. It is hypothesized that this inferiorly-directed force partially counteracts the superiorly-
directed force of the deltoid, resulting in decreased shear forces on the glenoid baseplate-bone
interface.

Three cadaver shoulder specimens were dissected and implanted with the reverse TSA. The
rotator cuff was completely released to simulate a massive rotator cuff tear. Each shoulder
was mounted in a shoulder controller that simulates neuromuscular control and replicates in vivo
glenohumeral kinematics. The controller utilizes an optical, three dimensional tracking system.
The humerus was weighted to simulate the full mass of the upper extremity and stepper motors
were connected to the insertion points of the anterior, middle and posterior divisions of the
deltoid by Spectra® cord. Simulated active abduction in the scapular plane was performed using
position closed-loop feedback control. The joint reaction force at the glenosphere was measured
at 5° intervals from 30°-70°. A fourth stepper motor was then connected to the greater tuberosity
with 2.73kg applied to simulate a LDT and the test was repeated. Five trials were performed
under each condition. Four-factor ANOVA statistical analysis with Bonferroni correction and α
= 0.05 was performed.

After simulated LDT the JRF demonstrated an increase in magnitude at abduction angles
between 30° and 65° inclusive (p=0.033). The superiorly-directed shear force was significantly
decreased as a result of the LDT between 45° and 70° (p<0.0001). The compressive component
of the JRF was increased for all abduction angles (p=0.025). The force required to achieve
abduction increased for the middle deltoid (p=0.035) and anterior deltoid (p=0.036) for the
simulated LDT condition at all abduction angles. The posterior deltoid force required for
abduction decreased at all abduction angles (p=0.031).

In this model of reverse total shoulder arthroplasty concomitant transfer of latissimus
dorsi decreased the superiorly-directed shear force. In addition to providing improved external
rotation strength, these lower shear forces may have a protective effect on baseplate fixation by
reducing the risk of failure in shear. This may provide additional justification for the transfer.
Although superior shear was decreased, total JRF was increased as a result of an increase in the
compressive component. Further investigation is needed to determine the potential gain in joint
stability and whether the glenoid bone can support such elevated compressive forces.
Additionally, the force required in the anterior and middle deltoid was increased after the LDT.
This indicates the need for sufficient deltoid strength and rehabilitation.
Periprosthetic bone loss is one of the major concerns in total hip arthroplasty (THA). Several studies have reported that bone mineral density (BMD) decreases after THA especially in the proximal femur. The phenomenon is explained as an adaptive remodeling response of bone tissue to a significant alteration of its stress environment. The purpose of this study was to evaluate the pattern of load transfer after stem implantation, and to compare the stress of finite element (FE) studies to BMD in the proximal femur after THA.

Forty-eight consecutive patients who received a primary cementless THA with implantation of the same femoral prosthesis (VerSys, Zimmer Inc, Warsaw, Idaho) between January 2007 to December 2007 were identified. Twenty-nine patients were excluded for administration of alendronate or alfalfacalcidol, and four patients were lost to follow-up or had incomplete computed tomography (CT) or dual-energy X-ray absorptiometry (DEXA) data. The remaining 15 patients formed the basis of this study. The average age of the patients at the time of THA was 64 years (range, 44 to 82 years). BMD were measured with DEXA at 1 week and 12 months after THA. Regions of interest (ROIs) were defined according to Gruen's system (ROIs 1-7). FE models of the femur and stem were obtained from pre- and post-operative CT data by “Mechanical Finder (Research Center of Computational Mechanics Inc.)” that was a software to make FE models considering individual bone shape and density distribution. FE model of the femur consisted of approximately 600,000 elements and that of the stem consisted of 200,000 elements. The shaft was restrained and force was applied to the femoral head and directed within the coronal plane at 20° to the shaft axis. Stress distribution and strain energy density were analyzed and compared to DEXA data.

BMD maintained at 1 year after THA in ROI 3, 4, 5, and 6, whereas BMD decreased in ROI 1, 2, and 7 by 17%, 16%, and 26%, respectively. This means that BMD decreased especially in the proximal femur at 1 year after THA. FE studies revealed that the stress and the strain energy density in ROI 3, 4, 5, and 6 were much higher than in ROI 1, 2, and 7. It was suggested that high stress and strain energy density are contributed to maintenance of BMD in the femur at 1 year after THA.
FUNCTIONAL AND IMAGING OUTCOMES WITH HEMIARTHROPLASTY FOR ANATOMIC RECONSTRUCTION IN ACUTE FRACTURES OF THE HUMERAL HEAD

Russo R, Ciccarelli M, Vernaglia Lombardi L, Cautiero F, G. Giudice,

Aim: The treatment of the fractures to three and four fragments of the humerus still represents a challenge. The authors describe the surgical technique and results with a modular prosthesis that permits an anatomical reconstruction of the proximal humerus from the calcarside, that becomes the point reference of reconstruction with the "Puzzle-Pieces" technique.

Methods: From February 2000 to February 2007 41 patients were treated with modular prosthesis. They were 8 males and 33 females aged between 56 and 79 years. In 23 cases the interested shoulder has been the right, in 18 the left. All fractures were diagnosed with X-ray and CT-scan. The type of fracture includes: 20 fractures of four fragments, 15 pluri-fragmentary fractures, and 6 fracture/dislocations. At the follow-up we evaluated 26 patients.

Results: The functional results were evaluated in 26 patients by Constant score with a mean follow-up of 4 years. All the patients reviewed have executed a X-Ray, while in 18 cases we also have evaluated the reconstruction of the tuberosities with CT-scan. In one case there has been a complete resorption of the tuberosities with insufficiency of rotator cuff. The mean of forward elevation was 132°.

Conclusion: The plant of a humeral prosthesis for fractures is a very complex intervention. The technique, for modular prostheses it’s not very codified. Moreover the results from the Literature are inconstant in particular as to function of the shoulder, not predictable and often were it accompanied by complications. The technique we described consists in the identification and reconstruction of the medial part of calcar that becomes “the thread conductor” for restoration of the height and the retrotorsion of the humeral head.
In this report a novel surgical treatment of proximal humerus fractures with shoulder hemiarthroplasty through an anterolateral acromial approach is presented. This access allows a drastic reduction of the risk of iatrogenic neurovascular complications and was developed to allow less invasive treatment of proximal humerus fractures with an easy control of the tuberosities which are often dislocated. Furthermore, this access allows the conservation of the anatomical integrity of the rotator cuff muscle which is fundamental in older patients. After removal of the humeral head, by this antero-lateral approach a better visibility of glenoid cavity is achieved thus allowing a more correct prosthesis components placement and an easier fixation of the tuberosity around the prosthesis using strong non-absorbable suture.

Over a 2-years period, 24 patients (age 68.9, range 53-83, 17 females and 7 males) with either displaced 4-parts fractures, according to Neer classification, or fracturedislocations of the humeral proximal third, were surgically treated through a shoulder hemiarthroplasty with direct antero-lateral acromial approach. Clinical and functional assessments were performed at 3, 6, 12, and 18 months including the determination of the Constant Score, the radiographic assessment in an antero-posterior and axillary view of the humerus, a photographic documentation of the injured shoulder function as compared with the non-injured extremity and the assessment of the upper limb motion with a motion analysis system.

An increase in mean Constant Score and ranges of motion was observed over the follow-up-period. At 12-months follow-up the Constant Score was 62.2 points (range 41-91) out of a total of 100. Patients at 12 months showed a mean active flexion of the shoulder in the sagittal plane of 45.8 degrees (range 19.1-89.4); the mean active abduction was 49.4 degrees (range 26.1-90.8) with forearm turned down and 57.1 degrees (range 16.7-119.2) with forearm turned up; the range of rotation was 30.9 degrees (range 26.2-35.6). Nevertheless, all patients were able to perform the activity with a relatively pain-free shoulder.

The results obtained in the present study are comparable with the literature data, where other surgical approaches were used. Due to its conservative features, the presented surgical approach may represent a good alternative in shoulder hemiarthroplasty.
CONSERVATIVE POSTERO-LATERAL APPROACH TO HIP. EVALUATION OF 500 CASES.
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The Gibson and Moore postero-lateral approach is one of the most often used in hip replacement. The advantage of this approach is an easy execution but it’s criticized because of its invasivity to muscletendinous tissues especially on extrarotators muscles and because of predisposition to posterior dislocation.

Since June 2003 we executed total hip replacements using a modified postero-lateral approach which allows to preserve the piriformis and quadratus femoris muscles and to detach just the conjoint tendon (gemelli and obturator internus). Articular capsule is preserved and it will be anatomically sutured at the end of the procedure as well as the conjoint tendon with two transossesous sutures. Piriformis and quadratus femoris muscles result untouched by this approach.

We have executed 500 surgeries with this modified approach.
We have used different stems (straight, anatomical, modular and short) and press fit acetabular cup with polyethylene or ceramic insert and we have always used 36 mm femoral heads when allowed by the cup dimensions. We have used any size both of stems and cups without limitation due to the surgical approach. The mean age is 61.8 y.o., 324 females and 176 males. Obese patients, hip dysplasia Crowe 3 and 4 and post traumatic arthrosis are exclusion factors for the execution of this approach. If possible we have maintained the capsulo-tendinous less invasivity. The BMI is not an excluding factor because it’s just the gluteus region that is an important factor to decide if to execute or not a less invasive approach.

Analyzing our 500 cases we didn’t have any case of malpositioning of the stem in varus or valgus (more than 5°) and considering acetabular cup we had the tendency to position it in valgus position (not more than 40°) in the first 20 cases.
No leg discrepancies more than 1 cm were observed.
Intra-operative blood loss have been reduced of about 30 % and 50% in the post-operative. All the patients were able to active hip mobilization within the first day after surgery with a mean range of motion of 0-70°. The patients were mobilized the first day after surgery and 80% of them were able to assisted walk within second day after surgery. The mean time of stay in hospital was 6.8 days.

After 4 weeks 98% of the patients were able to walk without crutches.
One case of deep infection were evaluated and then solved with surgical debridement; no wound dehiscence. We had 1 case of anterior hip dislocation in dysplastic arthrosis due to a technical mistake. In 1 case we had femoral nerve palsy, then solved, probably because of anterior retractor malpositioning. We had 5 cases of piriformis muscle contracture without sciatic nerve palsy, then solved. We think that for total hip replacement this conservative postero-lateral approach, thanks to capsuleotendinous modification we have adopted, could be considered an anatomical approach, which doesn’t present more dislocation risks compared to other approaches to the hip also thanks to the introduction of 36 mm femoral head that gives more stability and proprioceptiveness. Besides this approach gives the possibility of a shorter rehabilitation as seen above and it could be consider optimal for total hip replacement.
INFLUENCE OF STEM LENGTH ON THE INSERTION PATH IN THR
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The current decade has seen a marked rise in popularity of minimally invasive hip replacement, done through a variety of surgical approaches. A specific downside to the direct anterior approach includes the significant difficulty getting a “straight shot” down the femoral canal for either straight, nonflexible reaming or broaching as with standard approaches. Improper alignment in the femoral canal can lead to sub-optimal load transfer and thus compromised fixation. The femoral broach and stem insertion path for this approach is best described as a curved one, rather than the typical straight path. Some femoral components appear to be more suitable to this technique due to their geometries. The purpose of the study was to describe the effects that the single geometric parameter, stem length, has on its insertion path into the femoral canal. Due to the potential introduction of human error associated with repetitively performing a specific motion, both a physical study and a computer generated analysis were conducted.

For the physical portion of the study, a femoral implant body of generic fit and fill geometry was designed and manufactured. The length of the stem was varied from 40 mm to 100 mm in 10 mm increments. A medium sized synthetic femur (Sawbones, Pacific Labs, Seattle, WA) was machined to match the volume of the full length stem. The insertion path constraints were defined such that the stem had to maintain the greatest allowable insertion angle while still making contact on both the medial and lateral side of the canal during translation in the X direction. To reduce the variability in applying the constraints, a single author conducted the insertion procedure for each length stem while the path was videotaped from a fixed position directly in front of the setup. The most proximal lateral point of the stem was tracked through the insertion path and the X, Y coordinates were recorded at a frequency of 2 FPS. The area under this curve, referred to as the minimum insertion area (MIA), was calculated.

For the computer generated portion of the study, a CAD model of the standard length Omnifit® (Stryker Orthopaedics) was utilized. The stem was modified to create 5 additional models where the length was progressively shortened to 65%, 55%, 45%, 35%, and 25% of original length or 91mm, 77mm, 63mm, 49mm, and 35mm respectively. The femur was created from a solidified mesh of a computed tomography (CT) scan with the canal virtually broached for a full length stem. The models were each virtually assembled within the femoral canal with the similar constraints as the physical study. Again, the most proximal lateral point of the stem was tracked through the insertion path with the coordinates recorded and the MIA was calculated.

There was a non-linear relationship between stem length and the MIA with the rate of change decreasing as the stem length decreased. That is, the greatest decrease in MIA was between the standard length and next longest length in the computer simulation. It was noted that marked change in MIA began to subside between the 77mm and 63mm stems and continued this trend of having less influence onward through to the shorter lengths. Although the results of the physical study showed a higher variability than the computer generated portion, it does confirm the results of the computer generated study.

Minimizing the trauma associated with THR has led most of the above authors to the direct anterior approach. However, the femoral broach and stem insertion path is best described as a curved one, rather than the typical straight path used in other approaches. This curved insertion path also has benefits for other approaches since the broaches and stem can be kept away from the abductors, minimizing the potential injury to them. Shorter stem length makes this curved insertion path easier to perform. This is the first study to describe the effect that stem length has on its insertion path into the femoral canal. As expected, the physical portion of the study showed more variability than the computer generated portion. However, the physical and computer studies correlated well, with shorter stem lengths clearly allowing a more curved insertion path. The improvement tapered off in stem lengths below 63mm. This length correlates well with the other attempts at a shorter stem. This study provides quantitative data to help with shorter stem design and possible computer navigated insertion paths.
RADIOLOGICAL OUTCOME OF REVERSE SHOULDER ARTHROPLASTY FOR ACUTE COMPLEX PROXIMAL HUMERAL FRACTURES IN ELDERLY POPULATION WITH A 1 TO 15 YEAR FOLLOW-UP

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Synthesis and hemi-prosthesis give well known radiological results for acute proximal complex humeral fractures in elderly population. We wanted to expose the radiological outcome of the reverse concept in this indication.

From 1993 to 2008, forty four DELTA III were implanted for thirty three three-part and four-part displacements and eleven fracture-dislocations, in 3 males for 41 females, with an average age of seventy five years. The results were estimated with AP and LAMY profile Xrays.

Because of ten deceases and three moving, thirty one cases were reviewed with a mean follow-up of 6.3 years, range 1 to 15. The radiographs showed : two 2-mm thick borders on the glenoid at four and eight years with a scapular notch at 11 years and an aseptic loosening of the base plate at 12 years with a broken polar inferior screw. The patient underwent an easy surgical revision because of a fair bone stock. There was no wear of the polyethylene. According to the NEROT classification , nineteen inferior scapular notches were observed with a mean occurrence time of 4.6 years. The seven type-1 notches appeared at a mean of 2 years and the five type-2 notches at a mean of 4.3 years. We observed four type-3 notches which reached the inferior screw at 5,6,7 and 8 years, and three type-4 notches which extended beyond the inferior screw at 6,7 and 8 year follow-up, respectively. There seem to be two distinct patterns of notches: mechanical, stable proximal humeral bone loss because of an impingement between the humeral component and the inferior scapular pillar and biological, progressive in size, evolving over time with proximal humeral bone loss because of polyethylene disease; the longer the follow-up, the more severe the notch. Fourteen inferior spurs, stable after emergence, were reported with a mean occurrence time of 2.5 years range 1 to 6 years. One joint ossification occurred at 6 months and was stable at 6 year follow-up. The humeral results consisted in five medial (5,6,710, and 11 years) proximal bone lososes and three bone-cement interface medial borders on the two thirds of the height of the stem at a mean follow-up of 5 years. In these eight cases, there was a notch associated. We reported one case of septic humeral loosening at 2 year follow-up.

For acute proximal humeral complex fractures in elderly population, when re-fixation of the tubercles on the classical orthopaedics devices is impossible, the use of a DELTA III prosthesis shows, with a mean follow-up of 6.3 years, worrying images in 70% of the cases. These images are on the glenoid in 70% of the cases, appeared before seven years in 86% and are progressive in 50% of the cases. But, we have only one re-intervention for an aseptic loosening of the base plate at a twelve year evolution. New developments in design and bearing surfaces and a more long term results will probably provide more durable utilization of the reverse concept in this indication.
FUNCTIONAL OUTCOMES OF BILATERAL HIP NECROSIS: TOTAL HIP ARTHROPLASTY VERSUS EXTRACORPOREAL SHOCKWAVE
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This study compared the functional outcomes of total hip arthroplasty (THA) in one hip and extracorporeal shockwave (ESWT) in the other hip in patients with bilateral hip necrosis.

Seventeen patients with bilateral hip necrosis were treated with THA for late stage ONFH in one hip and ESWT for early lesion in the other hip. In THA, only one type of prosthesis was used and all components were cementless. In EWST, each hip received 6000 shocks at 28 Kv (equivalent to 0.62 mJ/mm² energy flux density) in a single session. The evaluations included pain score, Harris hip score, radiographs and MR images at 6 and 12 months and then yearly.

Significant improvements in pain score and Harris hip score were noted after treatment in both hips. However, the magnitudes of improvement showed significant differences between the two sides favoring the ESWT side. On subjective assessment, 13 patients rated ESWT better than THA; 4 patients reported comparable results of THA and ESWT, and none graded THA better than ESWT. In THA side, abnormal radiographs were noted in 47% (8 of 17) including component mal-position, nonprogressive radiolucency, and suspected component loosening. In ESWT side, significant reduction of bone marrow edema and a trend of decrease in the size of the lesion were observed after treatment.

ESWT and THA are effective for early and late stages of ONFH respectively. However, better functional outcomes were observed in ESWT-treated hips than hips treated with THA in patients with bilateral hip disease in short-term.
EXTRACORPOREAL SHOCKWAVE SHOWS REGENERATION IN HIP NECROSIS
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The effect of shockwave in osteonecrosis of the femoral head (ONFH) is poorly understood. The purpose of this study was to investigate the regeneration effects of shockwave in ONFH.

This study consisted of 14 femoral heads from 14 patients undergoing total hip arthroplasty for ONFH. Seven patients with seven hips who received shockwave prior to surgery were designated as the study group, whereas, seven patients with seven hips who did not receive shockwave were assigned to the control group. Both groups showed similar demographic characteristics. The femoral heads were investigated with histopathological examination and immunohistochemical analysis with von Willebrand factor (vWF), VEGF, platelet endothelial cell adhesion molecule-1 (PECAM-1) also referred to as (CD 31) and vascular cell adhesion molecule (VCAM) for angiogenesis, and with proliferation cell nuclear antigen (PCNA), Dickkopf-1 (DKK1) and Winless 3a (Wnt 3) for bone remodelling and regeneration.

In histopathological examination, the study group showed significantly more viable bone and less necrotic bone, higher cell concentration and more cell activities including phagocytosis than the control group. In immunohistochemical analysis, the study group showed significant increases in vWF (P<0.01), VEGF (P<0.0012) and CD 31 (P<0.0023), Wnt3 (P<0.008) and PCNA (P<0.0011), and decreases in VCAM (P<0.0013) and DKK1 (P<0.0007) than the control group.

Shockwave treatment significantly promotes angiogenesis and bone remodelling than the control. It appears that application of shockwave results in regeneration effects in hips with ONFH.
MINIMAL INVASIVE REVISION SURGERY WITH MODULAR NECK ADAPTORS (BIOBALL)
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The use of neck modular adapter is a relative new solution for hip revision arthroplasty. This device assures a lot of advantages for the orthopaedic surgeon because Bioball can be used in different situations in order to solve different complications: hip prosthesis dislocation, correction of length (up to +21mm), save an old stem not mobilized, reduction of operation length.

The hip prosthesis dislocation, in spite of the continuous progress of implants’ materials and design, is still an actual event in the orthopaedic clinical practice, both after total hip replacement or an endoprosthesis. Furthermore, dislocation has an important social-economic impact because of a protracted hospitalization and rehabilitation and elevated costs of an eventual revision. Although using heads with a diameter larger than 28 mm we obtain virtually a greater range of motion, with a contemporary increase of degree necessary to cause the head-neck impingement, the risk of dislocation hasn’t a significant increase using head with a diameter of 22 mm.

Neck modular adapters (Bioball) allow to correct easily the biomechanics parameters of the dislocated prosthetic joint, avoiding the revision of the stem. Other indications for the use of the neck modular adapter are total hip replacement and intraoperative correction of the limb length. Vantages are the possibility to obtain a great range of motion through a small thickness of the 12/14 adapter, the possibility to extend the limb length up to 21 mm and to use ceramic heads during revisions, because the combination head/neck has a tribological unwearred surface. In fact, in normal conditions, if the stem is not mobilized, the use of ceramic head is rash; the Bioball adapter, instead, can be used with a old stem, so we can set a ceramic head. Every stem with a Biolox cone can be combined with a metal or ceramic head up to the 5XL size (+21 mm) through a Bioball adapter; in this way the cup is not removed.

We have two kinds of neck modular adapters: 12/14 allow both to extend the neck and to correct the offset, and 14/16 that allow to extend only the neck, because of the largest diameter of the prothetic neck and the small thickness of the adapter. For these neck modular adapters exist different sizes, from M to 5XL (+21mm). Recently to these two types of Bioball were introduced also solutions for special stems (like for Exeter, ABG I, ABGII, PCA and others).

We have also proving heads and necks. The proving and definitive heads have to be of the Bioball system because these are inserted on a modular neck with a no-standard diameter.

In the common practice the use of these adaptors has not to be considered as a routinary procedure, but have to be taken in consideration as a valid aid for orthopaedic surgeon to quickly and less invasively, solve technically demanding procedures with a real benefit for high-surgical risk patients.
NEW SURGICAL TREATMENT USING A DOCKING NAIL FOR PERIPROSTHETIC FEMORAL FRACTURE AFTER TOTAL HIP REPLACEMENT

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[Objective] The number of hip prostheses replacement surgeries particularly in elder people with osteoporosis, has been increasing every year; given this scenario, treatment of postoperative periprosthetic femoral fracture has become a critical problem. Osteosynthesis is generally selected as the procedure of choice for the surgical treatment of fractures, provided the stem prostheses do not show loosening. Stable fixation of periprosthetic femoral fracture is difficult in the elderly because they have osteoporotic bone and most of the intramedullary space is occupied by the metal stem implanted in the proximal femoral shaft. With a view to solving this problem, we developed a new surgical treatment for postoperative periprosthetic femoral fracture; this procedure use a trimming intramedullary nail, which we have termed “docking nail.”

[Materials] The subjects were 3 patients (81, 75 and 76 years old) who had suffered a femoral shaft fracture around the femoral prosthesis after total hip replacement; in all 3 patients, there was no apparent sign of loosening of the stem prosthesis. The implanted stem was cemented in one patient and uncemented in the other two.

[Method] Using information on the size and shape of the stem prosthesis as well as information from the preoperative radiographs, we cut the docking nail till the proper length was achieved and trimmed it to suit the cutting site in order to ensure that it was compatible with tip of the stem. We then performed osteosynthesis using instruments of an ordinary supracondylar type intramedullary nail. In cases where it was difficult to reposition or where it was necessary to remove excessive cement and bone from around the tip of stem and graft a free bone in the bony defect, we exposed the fracture site as minimally as possible. The major difference between our procedure and the conventional procedure is that in our procedure, the docking nail is connected to the tip of the implanted stem to ensure proper alignment. Postoperative immobilization was not used in any of the patients except for the 81-year-old patient, for whom partial weight-bearing was allowed at 4 weeks, and full weight bearing at 12 weeks. The mean follow up period was 22 months (range, 6-48 months).

[Result] Within 3 months, bony union with good alignment was achieved in all 3 patients without malunion or infection. The clinical and radiographic examinations conducted during the follow-up period showed good results.

[Conclusion] The advantages of this method are that it is less invasive and simple compared to the conventional methods. Its only disadvantage is that it requires considerable, preoperative planning and minor trimming of the nail. Although this series is small, we think that this new treatment can be recommended and will be beneficial for treating periprosthetic femoral fractures without a loose stem. However, these preliminary findings need to be confirmed by further investigations.
LONG TERM EVALUATION OF THE PCL: 
A CLINICAL AND RADIOLOGICAL STUDY 
Dr. Ashok Rajgopal MS, MCh

We undertook a study of 52 knees in 34 patients who underwent a cruciate retaining total knee arthroplasty (TKA) for severely deformed knees. At an average follow up of 12 years the knees were evaluated clinically and radiologically by means of stress radiographs and Magnetic Resonance Imaging (MRI) to assess the functional status of the posterior cruciate ligament (PCL). The knee scores showed a consistent and sustained improvement over the pre-operative levels. Stress radiographs did not show any posterior translation of the tibia. In 43 knees an intact PCL was visualized on MRI scans.

These observations suggest that the PCL is present at long term review even in knees that underwent arthroplasty for severe deformities.
The Mayo-Stem is short and tapered in the anteroposterior and mediolateral directions, designed to enhance early fixation through multiple point contact in the proximal medullary cavity. The purpose of this study was to investigate the clinical and radiographic results of total hip arthroplasty (THA) using this short stem in younger patients.

A total of 97 cementless THAs using this short stem were investigated. The length of the stem used ranged from 90mm to 110 mm. The average age of the patients at the time of surgery was 50.9 years (33-64 years). The average follow-up period was 64 months (38-108 months). The Harris hip score was used for clinical evaluation. The valgus angles of the stems and the changes in radiographic findings around the stems after surgery were investigated on the AP radiographs of hip.

The average Harris hip score was 52.0 points preoperatively and 93.9 points at the latest follow-up. An intraoperative femoral fissure fracture of the proximal femur occurred in 15 hips (15.4%), which were treated by circlage wires. The average valgus angle of the stem was 3.5° (range: -6°-18°). The development of bone trabeculae was seen around the curve of the stem (Gruen zones 3 and 5) in 79.4 % of hips one year after surgery. A radiolucent line was found on the lateral side of the stem (Gruen zones 1, 2, and 3) in 13.4 % of hips, which occurred in connection with the development of bone trabeculae. Subsidence of the stems (> 2mm) was seen in three hips in which intraoperative femoral fissure fracture had not occurred. These hips did not get the development of bone trabeculae. In two hips of the three hips, the valgus angles of the stems were 15° and 17° respectively. In the case of the third hip, the stem was small to the proximal femur.

Overall the clinical result of THA using a short- stem was basically gratifying. The development of bone trabeculae, the stem size to the proximal femur and the stem position were important factors for the fixation of stem. Intraoperative fissure fracture treated by circlage wires and radiolucent lines with the development of bone trabeculae did not affect the fixation of stem.
The purpose of this study was to analyze the long-term effect of arterial perfusion of drugs and bone marrow stromal cells (bMSCs) on osteonecrosis of femoral head (ONFH). From Jan 1997 to Mar 2004, one hundred and seventeen patients with ONFH were consecutively enrolled to receive a digital subtraction angiography (DSA) in arteriae circumflexa femoris medialis and arteriae circumflexa femoris lateralis. In DSA, a dosage of drugs (urokinase, salvia injection, and tetramethylypyrazine) and autologous bMSCs or only the drugs were perfused into the arteries. The morphological changes of the arteries in DSA after perfusion were recorded. Symptoms radiographs, and the Harris hip-rating score were determined preoperatively and at each follow-up examination at one month, six months, one year, 2 years and 5 years after the treatment. 83 patients were followed up for more than five years. The median follow-up period was 7.9 years.

After the drugs had been perfuse, the arteries became thicker, and more than 2 branches appeared in DSA. Five years after the operation, the Harris hip score of 32 patients (38 hips) treated by arterial perfusion of simplex drugs (group A) increased from 59.24±5.28 to 71.80±6.37 (p < 0.01), and the excellent and good rate of centesimal evaluation was 57.9%. The Harris hip score of 51 patients (59 hips) treated by arterial perfusion of drugs and autologous bMSCs (group B) increased from 59.52±4.85 to 78.29±6.05 (p < 0.01), and the excellent and good rate was 78.0% which was significantly higher than that of group A (p=0.035). Since two years after operation, the Harris hip score of group A was significantly higher than that of group B (p < 0.01).

Among the patients in group B, the rate of excellent and good in early stages (a and b according to Ficat classifying, 50 hips) was 84.0%, which was better than the rate in the terminal stage (Ficat III, 9 hips, the excellent and good rate was 44.4%)(p = 0.028), and the rate of excellent and good in low age group (< 40 years, 33 hips) was also better than that in high age group (≥ 40 years, 26 hips)(p=0.038).

We conclude that arterial perfusion of drugs and autologous bMSCs treating osteonecrosis of femoral head is safe and effective. The long-term therapeutic effect is more satisfactory than that of simplex arterial perfusion of drugs.
A NOVEL METHOD FOR FEMUR RESECTION IN TKA: IN VITRO COMPARISON AND IN VIVO FOLLOW-UP
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Resection of the distal femur to properly fit the prosthetic component is a crucial step for prosthesis alignment during TKA. In this study, we development a new integrative (Five-In-One, FIO) femur resection method, which performs distal femoral resection in one procedure instead of the standard five cutting steps. The accuracy and operating time are comparable to the conventional cutting methods using foam bone model experimentation and in 9 patients.

**In vitro comparison:** Uniformly-sized foam bone femur models were used in this study. New five-in-one cutting devices and conventional cutting devices of the same prosthetic size of #44 were installed and resection of the distal femur by five experienced orthopaedic surgeons. Each surgeon performed five cases with each device. Then a femoral prosthesis (#44) was installed on each cut femur mode and anterior-posterior and lateral X-ray radiographs were taken. The angles, facet length and distance between anterior and posterior oblique facets were then measured with goniometer and vernier calliper. The corresponding angles from a standard femoral prosthesis (#44) were also measured. The angular difference between the resection femur and prosthesis was calculated and named Angular Deviation. The valgus angle and anteversion angle were measured on anterior-posterior and lateral X-ray radiographs respectively. The mean value from the five measurements obtained from each surgeon using the same cutting method was used for the comparison of the modified and standard resection model. The operating time of each cutting procedure was recorded. students’ t-tests were used for the statistical analysis.

**In vivo following up:** 9 patients with use of the five-in-one cutting instrument and the Deluxe prosthesis have been evaluated during operating, and followed up for at least one year. Operating time were recorded and HSS clinical and functional scoring systems before the surgery, three months and one year after surgery.

The angular deviation of the new FIO Cutting Device was significantly less than the conventional device in all four anatomic measurements (p < 0.05). The distance deviation in the FIO group was also significantly less in the FIO group compared to the conventional procedure (p < 0.05). The average valgus angle and anteversion angle of the five-in-one cutting device which were measured on anterior-posterior and lateral X-ray radiographs respectively were 6.86° and 3.02° respectively. They were not significantly different when compared with the data of the conventional cutting device, which were 6.56° and 3.06° respectively. The mean of the cutting time of the five-in-one device was 9.70 minutes, which was significantly less than the conventional cutting device which was 21.84 minutes averaged (p < 0.05).

Our data demonstrated that the angular accuracy of the distal femoral resection with the newly Five-in-one technique was greatly improved compared to the conventional cutting method. With the use of the new technique, operative time was also shortened over two folds compared to the conventional method. We conclude that the new five-in-one cutting device is more accurate and shorten operating time compared with the conventional device in the vitro study.

The mean HSS score before surgery was 48.69, 84.7 three months after surgery, and 85.6 at one year after surgery. The survivorship was 100% of patients.
CLOSED WEDGE HIGH TIBIAL OSTEOTOMY USING COMPUTER ASSISTED SURGERY COMPARED TO THE CONVENTIONAL TECHNIQUE

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In conventional high tibial osteotomy it is difficult to obtain the ideal correction angle consistently and there is high variability of postoperative alignment. We assessed the reliability, accuracy and variability of closed wedge high tibial osteotomy using computer-assisted surgery compared to the conventional technique. Fifty closed wedge HTO procedures were performed and analysed between July 2005 and July 2006, using the CT-free navigation system (Vector Vision® version 1.1, BrainLAB, Heimstetten, Germany) for medial compartment osteoarthritis of the knee and fifty knee operations using conventional closed-wedge HTO, performed between 1994 and 2006, were retrospectively reviewed as a control group. The mean age was 59.4 years for the navigation group and 60.7 years for the conventional group. In the navigation group, the mean mechanical axis (MA) before osteotomy was varus 8.2°, and the mean MA after the fixation was valgus 3.6°. On the radiographs, the mean preoperative MA was varus 7.3°, and the mean postoperative MA was valgus 2.1°. In the conventional group, the mean MA was varus 10.6° preoperatively and valgus 0.1° postoperatively via the radiograph. The mean preoperative posterior slope angle (PSA) was 11.0°, which decreased to 9.0° in the navigation group. The mean preoperative PSA was 10.4°, which decreased to 6.4° in the conventional group (p = 0.000). There was a positive correlation between measured data taken under navigation and by radiographs (r > 0.3, P < 0.05). The mean correction angle was significantly more accurate in the navigation group (p < 0.002). The variability of the correction was significantly lower in the navigation group (2.3° versus 3.7°, p = 0.012), and the distribution of MA was also narrower in the navigated group.

We concluded that navigation provides reliable real-time intraoperative information and may increase accuracy, and improve the precision of closed-wedge HTO.
HUMERAL RESURFACING EMIARTHROPLASTY.
OUR TWO YEARS EXPERIENCE (PRELIMINARY REPORT)
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Aims: The innovative surgical procedure of humeral resurfacing emi-arthroplasty is currently used for the treatment of younger patients, in need of a bone-preserving implant, affected by primary gleno-humeral osteoarthritis and rheumatoid arthritis, secondary degenerative joint disease, post-traumatic arthritis or mal-unions of the humeral head, loss of articular cartilage, joint incongruity and stiffness, avascular osteo-necrosis of the humeral head, combined loss of the gleno-humeral joint surface and rotator cuff loss of function and pain unresponsive to nonoperative measures. Published reports have indicated a large variation in the benefits of this procedure. The aim of this study is to analyse the clinical results obtained by the authors in a preliminary report of a two-years experience in the surgical actuation of this procedure, that represents one of the most innovative options in the field of the shoulder arthroplasty.

Materials and Methods: The authors report the outcomes of their experience in humeral head surface replacement emiarthroplasty. In the last two years 25 selected patients have been treated according to the surgical implantation of the “bone sparing” Global Cap conservative anatomic prosthesis (DePuy). The mean age of the patients was 52 years (range, 34 to 76 years). They have been followed for a mean of 8 months, (range, 4 to 16 months). Preoperative diagnoses were: osteoarthritis, rheumatoid arthritis, psoriasic arthritis, osteonecrosis and post traumatic arthritis. 8 patients underwent contextual cuff tear repair.

Results: Constant score for the whole group improved from a mean preoperative score of 22 to 60 at the last follow-up. Periprosthetic osteolysis was seen in 3 cases. One case of stiffness required narcosis mobilization at 5 months after surgery. Our results are comparable to those obtained with others modern R.R.H. and are similar to Copeland’s own series.

Conclusions: The preliminary results of our study show how some pre-operative factors appear to influence the functional improvement and the personal satisfaction rate of the patients after humeral resurfacing emiarthroplasty. The most important are represented by: the presence of erosions in the glenoid cartilage, possible previous shoulder surgery and associated cuff tears. The gender of the patients doesn’t appear a discriminating factor. The age appears to influence only boundedly the clinical post-operative outcomes. In our opinion, the initial diagnoses is determinant: patients affected by systemic pathology, like rheumatoid arthritis, or by cuff tear obtain the least functional improvement and satisfaction; on the contrary, patients affected by primary and secondary degenerative joint diseases, posttraumatic cartilage lesions and avascular osteonecrosis of the humeral head obtain better results.
Introduction: Uncemented proximally filling porous-coated femoral components must be designed with an optimal level of press-fit. Excessive press-fit yields higher femoral stress which can result in periprosthetic femoral fracture (PPFx), whereas insufficient femoral stress can lead to a lack of initial mechanical stability, which “is necessary to achieve bone ingrowth into the porous surface” (Manley P.A. et. al., J Arthroplasty 10:63-73, 1995) of the implant. An optimal press-fit design should also provide an accurate and repeatable femoral stem seating height in all patients.

A battery of cadaveric tests, physical “bench-top” tests, and finite element analyses (FEA) should be used in order to both quantitatively and qualitatively optimize a femoral press-fit design. In this study, a method is proposed to quantitatively rank candidate press-fit stem designs relative to successful predicates based on stem seating height and PPFx risk by recreating impact loading applied during surgery through a controlled “bench-top” model.

Methods: Three press fit candidate designs A, B & C and two clinically successful predicate proximal fit and fill stems (Secur-Fit™ Max (Fit & Fill 1) and Meridian® TMZF® (Fit & Fill 2), Stryker, Mahwah NJ) were evaluated. Five foam cortical shell Sawbones® femur samples (Item# 1130, Pacific Research Laboratories, Inc., Vashon, WA) were prepared for each press-fit design. A stem impactor was attached to the stem and then the stem was hand inserted in the femur. Then the construct was mounted in the drop tower using a vice and initial drop height was set to generate approximately 5500 N of impaction force when fully seated. Each stem was serially impacted until stable then step loaded until PPFx occurred. The height above/below the medial resection plane was measured after each impaction.

Results: All press-fit designs had an initial stable seating height within the desired range without causing PPFx, using an average impaction load of 5341 N. All of the press-fit designs required, on average, roughly a 200% increase in impact load (10925 N) to cause PPFx. The press-fit design which ranked first based on seating height accuracy, defined as the design closest to zero at stable, was Design C at -0.02 mm countersunk. Design A with a standard deviation of 0.09 mm ranked first for repeatability, defined as the design with the smallest standard deviation at stable. Finally the press-fit design which ranked first for lowest PPFx risk, defined as the design that is most countersunk prior to PPFx, was Fit & Fill 1 at 6.30 mm countersunk.

Discussion: This controlled “bench-top” impact loading model successfully showed that it can quantitatively evaluate stem seating height and PPFx risk for several different femoral press-fit designs. In order to determine the optimal design, each press-fit design was ranked with equal weight given to seating height and fracture risk. Using this test method one design alternative, press-fit Design C, ranked first as the optimal combination of seating height accuracy and consistency with a low risk of PPFx. A limitation of this imaption model is that it does not directly predict PPFx rate, it only quantifies risk of fracture. Another limitation is that this model does not simulate all of the variability that is inherent to actual patient bone types. This test is one step in a battery of tests, including cadaveric evaluation and FEA, which should be used in order to optimize a femoral press-fit design.
SHORT STEMS: ARE THEY SAFE?
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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, previously published clinical investigations with custom short stems have reported very encouraging results (Walker, et al, 1,2), 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.

Several basic questions must be addressed. First, what is the purpose of a stem? Second, can stem length be reduced and if so by how much can this be safely done. Third, 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(Walker, et, al.). 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. This was correlated with observations of prospective DEXA measurement of proximal femoral bone mass and implant migration following THR (Leali, 3).

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, inherent to its design, a provision for sufficient contact with both the medial and lateral proximal metaphyseal femur. As well it must also have a flat posterior surface parallel to, and in contact with, the posterior surface of the proximal femoral metaphysis. These conditions will provide support against distal migration as well as bending moments in the A/P plane. As a consequence of this latter condition, 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.

In conclusion, this study demonstrates that 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 should undergo rigorously in vitro testing before being released for implantation.

References
METAL PROXIMAL RADIUS ENDOPROSTHESES: THE STANMORE EXPERIENCE
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There is limited literature available on the use of metal prosthetic replacements for the treatment of non-traumatic lesions of the proximal radius. This study discusses the implant survivorship and the functional outcome of the elbow following insertion of metal proximal radius endoprostheses performed at the Royal National Orthopaedic Hospital.

We present a series of six patients treated with endoprosthetic reconstruction of the proximal radius following resection of non-traumatic pathologies. The patients included four females and two males, with a mean age of 39 years at the time of surgery. Their diagnoses included Ewing’s sarcoma, chondroblastoma, benign fibrous histiocytoma, radio-ulna synostosis and renal carcinoma metastases in two patients. Follow-up extended to 192 months with a mean of 76 months. During this time there were no complications with the prostheses, the most recent radiographs demonstrated secure fixation of the implants and none required revision. One patient developed posterior interosseous nerve neuropathy following surgery, which partially recovered, and another patient passed away as a result of disseminated metastatic renal cell carcinoma which was present preoperatively. The patient with radio-ulna synostosis had a 25° fixed flexion deformity of the elbow post-operatively but good flexion, supination and pronation. All other patients had full ranges of movement at the elbow. Functional scores were assessed using the Mayo Elbow Performance Score with patients achieving a mean score of 86 out of 100.

The results of the use of proximal radial endoprostheses for treatment of non-traumatic lesions are encouraging with regards to survivorship of the implant and functional outcome of the elbow.
TOTAL HIP ARTHROPLSTY (THA) USING POSTERIOR APPROACH
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Total Hip Arthroplasty (THA) using posterior approach (PA) that resect muscle have done from September, 2005 to August, 2006, but, for the purpose of a lower invasive surgery, we changed to THA using direct anterior approach (DAA) that preserve muscle from September, 2006. The purpose of this study was to compare the inflammation degree and clinical results of MIS-THA using PA with that of MIS-THA using DAA.

From September 2005 to May 2008, 73 hips in 69 patients were treated with consecutive primary cementless MIS THA. The breakdown of the patients was DAA, 51 hips, and PA, 22. The average age at operation was 66 years and 58 years. The average followup after primary THA was 1.5 years and 2.8 years. The sex ratio (M/F) was DAA 2/44, and PL 6/15. For the inflammation degree, CRP at the seventh day and 14 day after surgery of DAA was significantly lower than those of PA (p<0.01). WBC of the seventh day of DAA was significantly lower than that of PA. CPK on DAA at the first was significantly lower than that of PL (p<0.01), and CPK of PL took time for a long time to decrease to the level before the operation compared with DAA. For clinical results, there were no significant difference operative time, blood loss volume and complication in DAA and PA. No significant differences in the HHS at the final follow up were observed between DAA and PA. In the radiographic assessment, there was no significant difference in neutral position of stem of DAA(46hips) and PA (18hips), and there was no significant difference in abduction angle of socket in DAA(average 45°) and PA (47°). The day of SLR possibility was significantly earlier DAA (average 4 day) than PA (7). No significant differences in hospital stay were observed between DAA (average 21days) and PA (26).

In the current study, there was thought that DAA was lower inflammation degree than PA, because normalization of CRP after surgery in DAA was significantly early in comparison with PA, and CPK of the first day after surgery was significantly lower in DAA than in PA. In the clinical assessment, the day of SLR possibility only was significantly earlier in DAA than in PA. This may imply muscle recovery of DAA is more rapid than that of PA. In the future, DAA will help to the further early rehabilitation and the early hospital discharge.
Introduction: While plain radiographs are the clinical standard for routine follow-up after total knee arthroplasty (TKA), periprosthetic osteolysis can be difficult to identify on radiographs because it is often obscured by the metallic prosthesis. This study sought to evaluate the pattern and size of periprosthetic osteolytic lesions after TKA in patients with rheumatoid arthritis using multi-detector computed tomography (MDCT).

Methods: We evaluated 25 primary cemented alumina-ceramic TKAs (LFA-I, Kyocera) using minimum 10-year CT scans. All TKAs had an alumina-ceramic femoral component, a titanium tibial baseplate with a polyethylene insert, and a polyethylene patella component, which had been fixed with cement. The average age at the time of surgery was 54.1 years. The average time interval between surgery and the computed tomography scan was 12.6 years. None of the patients in this study documented periprosthetic infection or had undergone bone grafting.

Results: The MDCT detected 31 lesions in 12 knees: 23 femoral and 8 tibial lesions. All lesions occurred around the prosthetic rim, and the mean size of osteolysis per knee was 2.1 +/- 1.5 cc (range, 0.4-4.7 cc). Only seven lesions in 6 knees were diagnosed as osteolysis on plain radiographs: 2 lesions at anterior femoral condyle and 5 lesions at tibial condyles. None of the lesions around the posterior condylar flanges detected on CT was identified on plain radiographs. None of the implants showed radiographic loosening or required reoperation.

Discussion: As the alumina-ceramic TKA allowed the CT scans to obtain clear images with little metal artifact, we could easily detect lesions and joint space communication. This study demonstrated that plain radiographs underestimated osteolysis, and that lesions around posterior femoral condyles were the most difficult to identify on radiographs. Although most of the lesions were small and may be of little clinical importance, this study confirmed that MDCT can accurately detect osteolysis and measure lesion volumes in alumina-ceramic TKA.
SAFE ZONE FOR TRANSACETABULAR SCREW FIXATION IN PROSTHETIC ACETABULAR CUP RECONSTRUCTION OF HIGH-RIDING HIPS
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Prosthetic reconstruction of high-riding hips is technically demanding. Insufficient bony coverage and osteopenic bone stock frequently necessitate transacetabular screw fixation to augment primary stability of the metal shell. We sought to determine the validity of the previously reported quadrant system, and if needed, to define a specialized safe zone for augmentation of screw fixation to avoid vascular injuries in acetabular cup reconstruction for high-riding hips.

Volumetric data from computed tomography enhancement scanning and CT angiography of eighteen hips (twelve patients) were obtained and input into a three-dimensional image-processing software. Bony and vascular structures were reconstructed three-dimensionally; we virtually reconstructed a cup in the original acetabulum and dynamically simulated transacetabular screw fixation. We mapped the hemispheric cup into several areas and, for each, measured the distance between the virtual screw and the blood vessel.

We found that the rotating centers of the cups shifted more anterior-inferiorly in high-riding hips than those in ordinary cases, and thus the safe zone shifted as well. Screw fixation guided by the quadrant system frequently injured the obturator blood vessels in high-riding hips. We then defined a specialized safe zone for transacetabular screw fixation for high-riding hips.

We conclude that the quadrant system can be misleading and of less value in guiding screw insertion to augment metal shells for high-riding hips. A new safe zone specific to high-riding hips should be used to guide transacetabular screw fixation in these cases.
QUADRICEPS-SPARING, MINIMAL-INCISION TOTAL KNEE ARTHROPLASTY, A COMPARATIVE STUDY: TWO-YEAR FOLLOW-UP
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We conducted a prospective, randomized study comparing the outcomes of total knee arthroplasty (TKA) respectively through a quadriceps-sparing (QS) approach and a MIS medial parapatellar (MP) approach at 2-year follow-up. Sixty patients (80 knees) with primary osteoarthritis were enrolled in this study. Patients were blinded to be treated with and randomized to be grouped by either MP group (40 knees) or QS group (40 knees). Thirty-seven MIS MP TKAs and thirty-eight QS TKAs completed the 2-year follow-up.

According to the isokinetic study, the recovery of muscle strength (peak muscle torque) and normalization of muscle balance (H/Q peak-torque ratio) were comparable in both groups at either 2-month or 2-year follow-up. Tourniquet and surgical time in the QS group was significantly longer (approximately 20 minutes) than that in the MP group. The hip-knee-ankle axis measured after surgery was significantly more varus in the QS group than that in the MP group. The axis in both groups did not significantly progress at 2-year follow-up. There were no infections and no revisions at 2-year follow-up in both groups. More outlier cases (4 knees) were noted in the QS group when compared with the MP group (no outlier). However, no differences regarding the clinic outcomes (including VAS, HSS knee score, ROM and satisfaction) were observed between these two groups after either two months or two years upon operation. In both groups, there was a significant improvement of these parameters at 2-year follow-up in contrast with 2-month follow-up and pre-operative status.

In this study, we conclude that MIS medial parapatellar TKAs could achieve comparable recovery of muscle strength, normalization of hamstring-quadriceps muscle balance and clinical outcomes when compared with QS TKAs; moreover it provides more reliable alignment and fewer complications than quadriceps-sparing TKAs.
AVOIDING MAJOR AND MINOR PITFALLS OF TWO-INCISION TOTAL HIP ARTHROPLASTY
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Great disparity appears in the literature regarding the occurrence of minor and major complications after two-incision total hip arthroplasty (THA). Advocates of two-incision THA contend that this minimally invasive surgical (MIS) technique provides faster rehabilitation with fewer restrictions and financial advantages stemming from shorter hospital stays and quicker returns to work. These advantages, however, cannot be fully realized unless the procedure can be performed within acceptable risk levels.

The operative, perioperative, and postoperative complications of a consecutive series of 200 two-incision THAs from a single surgeon were analyzed. Of the 8 femur fractures which occurred in this series, four occurred intraoperatively. All four were nondisplaced and treated with a cerclage cable through the anterior incision. The prosthesis was retained in each case. Of the four postoperative fractures, two were nondisplaced, permitting retention of the prosthesis. These were treated with a trochanteric plate with wiring above and below the lesser trochanter. The other two postoperative fractures were displaced, necessitating revision to a longer, uncemented stem and cerclage wiring.

Other complications in this series included two nondisplaced greater trochanter fractures >2cm, 14 asymptomatic greater trochanter fractures ≤2 cm, one malpositioned cup requiring revision, one loose stem, seven cases of heterotopic ossification ≥Grade 2, four dislocations, one superficial infection, 80 lateral femoral cutaneous nerve neuropraxias (78 of which resolved within six weeks), and four femoral nerve neuropraxias (three of which resolved in 6 to 12 weeks).

In this series, two-incision THA was performed with a low incidence of major complications but a high incidence of minor complications. Despite the minor complications, most patients experienced an accelerated recovery and rehabilitation owing to reduced tissue trauma.

To help surgeons avoid complications, we recommend periodic retraining sessions where concerns and pitfalls can be addressed and recent enhancements, taught. Superficial nerve complications, such as those encountered in high numbers in this series, can be avoided by moving the anterior incision slightly lateral and splitting the fibers of the tensor fascia lata. The risk of minor trochanteric fractures can be reduced by first laterализing broach-only stems with a long straight 9mm reamer and/ or by using direct visualization.
FINITE ELEMENT ANALYSIS OF CEMENT-BONE INTERFACE MICROMECHANICS: THE EFFECT OF CEMENT PENETRATION DEPTH
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The stability of cemented hip implants relies on the fixation of the cement mantle within the bone cavity. This fixation has been investigated in experiments with cement-bone interface specimens, which have shown that the cement-bone interface is much more compliant than is commonly assumed. Other studies demonstrated that the mechanical response of the interface is dependent on penetration of the cement into the bone. It is, however, unclear how cement penetration exactly affects the stiffness and strength of the cement-bone interface. We therefore used finite element (FE) models of cement-bone specimens to study the effect of cement penetration depth on the micromechanical behavior of the interface.

The FE models were created based on micro computed tomography (micro CT) data of two small cement-bone interface specimens (8x8x4 mm). The specimens had distinct differences with respect to interface morphology. In these models we varied the penetration depth, with six different penetration levels for each model. We then incrementally deformed each model in tension and in shear, until failure of the models. Failure was simulated to occur in the bone and cement when the local ultimate tensile stress was exceeded, by locally reducing the material stiffness to near zero. From the resulting force-displacement curves we established the apparent tensile stiffness and strength for each of the models.

Our results indicated that the strength and stiffness of the cement-bone interface increased with increasing cement penetration depth, both in tension and in shear. However, after reaching a certain penetration depth, both strength and stiffness did not further increase. This depth was dependent on the specific interface morphology. We furthermore found that the strength of the models was higher in shear than in tension. After failure of the models, damage was mainly found in the cement, rather than in the bone.

The FE-based techniques developed for the current study are suitable for exploration of a variety of aspects that may affect the cement-bone interface micromechanics, such as biological changes to the bone and variations of cement material properties.
Failure of internal fixation of intertrochanteric fractures is associated with delayed union or malunion resulting in persistent pain and diminished function. We evaluated 15 elderly patients treated with a tapered, fluted, modular, distally fixing cementless stem. At an average follow up of 2.86 years, mean Harris hip score improved from 35.90 preoperatively to 83.01 (P <0.01). Fourteen stems had stable bony ingrowth and one stem was loose. Distal fixation with a tapered fluted modular cementless stem allows stable fixation with good functional outcome in a reproducible fashion in this challenging cohort of patients.

Key Words: intertrochanteric fracture; complication; tapered ; modular; cementless; arthroplasty
OUR EXPERIENCE IN THE TREATMENT OF PERIPROSTHETIC FRACTURES USING THREE DIFFERENT TYPES OF LOCED PLATES: A CLINICAL AND BIOMECHANICAL STUDY
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We refer about our experience in treating of 30 Pts with periprosthetic fractures (15 involved the hip prosthesis and 15 involved knee prosthesis) from jan 2002 to june 2008 with three different kinds of locked plates. The first system used has been the L.I.S.S. based on titanium plates and screws with the screws inserted in the plate by thread holes, the second was the so-called O’Nil system with the steel plates and the titanium screws screwed in a titanium conical insert, the third hardware system was represented by steel screws and plates with the screws screwed on the thread plate hole.

The results have been good and excellent in the most part of the patients, with only one complication regarding a non-union and plate mobilisation settle using a bicortical screws series. Moreover we present our biomechanical study based on the collaboration with the Mechanical Engineering Department of our University regarding the relationship “screw-plate” using the Finite Elements Method (FEM), outlining the specific features of the three individual system of locked plates.
Transtrochanteric rotational osteotomy (TRO) is a controversial procedure with reported inconsistent results. We reviewed 50 patients (60 hips) who underwent this procedure for extensive osteonecrosis of the femoral head, focusing on varization to determine its effectiveness as a head-preserving procedure in young adults. The mean age of the patients was 28 years (range, 18-46 years). Using the Ficat-Arlet classification, 40 hips had Stage II and 20 hips had Stage III involvement. According to the classification system of Shimizu et al., the extent of the lesions were Grade C in 54 hips and Grade B in six hips; the location of the lesions were Grade c in 56 hips and Grade b in four hips. Minimum follow-up was 18 months (mean, 84 months; range, 18-156 months). The mean preoperative Harris hip score was 44.7 points (range, 32-62 points) which improved to an average postoperative score of 80.1 points (range, 44-100 points) at the latest follow-up. Forty-four hips showed no radiographic evidence of progression of collapse. Ten hips showed progressive collapse, seven hips showed progressive varus deformity, three hips had stress fractures of the femoral neck, and one hip had infection. We believe TRO with varization is worth attempting for extensive osteonecrosis of the femoral head in young adults, although failures and complications are not uncommon.
MID-TERM TO LONG-TERM FOLLOW-UP OF INFECTED TOTAL KNEE ARTHROPLASTY
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Background: In the present study, the characteristics and mid-term to long-term outcomes of total knee arthroplasty (TKA) associated infections treated with different types of approaches were evaluated.

Methods: A retrospective study of the results of 71 infected TKA treated between August 1993 and August 2005. The data included medical records, gender, periprosthetic infection (PPI) classification, patients’ comorbidities, PPI diagnostic criteria, microbiology and histopathology results, surgical and antimicrobial therapy, treatment modality, complications, follow up, and treatment results.

Results: Median age was 70 years (range 43–88). Median follow-up 5.8 years (range 2–12). Thirty-three patients had multiple risk-factors for PPI. The main pathogens isolated were Coagulase-negative staphylococci 26 (37%), Staphylococcus aureus 16 (22.4%). The treatment methods of TKA infection was two-stage exchange in 59 (83%), debridement and retention - 5 (7.2%), arthrodesis - 5 (7.2%), excision arthroplasty 2 (2.8%). At final followup, 17 knees (24%) had required reoperation: 10 knees (14%) - component removal for reinfection. Two knees were reinfected 3 times, three knees – two times. The median time to first reoperation for reinfection was 1.2 years (range, 0.04–2.5 years). By Kaplan-Meier survival analysis the estimated survivals free of reoperation for infection were 90.5% (confidence intervals, 85.3–96.1%) at 5 years and 82% (confidence intervals, 70.3–94.5%) at 10 years. The Knee Society scores: Pain scores, Functional scores, ROM improved.

Conclusions: TKA infections treatment is a difficult task leading to a high rate of unsatisfactory mid-term and long-term results. About one forth of patient require reoperation, 14% become reinfected in first 2.5 years. Half of reinfected patients get reinfeected repeatedly. In most cases patients are reinfected with the same microorganism but more virulent. TKA infection treatment option should be chosen according to the type of infection (acute or chronic), the duration of infection, the stability of the implant, the type of microorganism causing infection, bone quality and integrity, and the quality of the soft-tissue.
ACETABULAR CUP POSITIONING IN HIP REPLACEMENT SURGERY, A COMPARISON OF THREE DIFFERENT APPROACH IN TOTAL HIP ARTHROPLASTY

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Acetabular component malposition during total hip Arthroplasty (THA) increases the risk of dislocation, reduces the range of motion, and can be the cause of early wear and loosening. Variability in implant alignment also affects the result of THA. The purpose of this study was to compare acetabular cup positioning of three different approaches in THA.

Three different approaches for cementless THA were studied in 108 operations. The direct anterior approach was used in 56, the anterolateral approach in 32 and the posterolateral approach in 50. The same cementless cup was used in all cases. The same surgeon performed all procedures with mini-incision surgery, using different approaches. To determine the accuracy of the cups, the inclination and anteversion angles were measured with a CT-investigation of the pelvis.

There were no statistical differences between the three groups regarding means of the inclination and anteversion angles. But a significant range of variance, the lowest variations being in the group of the direct anterior approach, the highest in the group of the anterolateral approach.
Excessive implant migration and micromotion have been related to eventual implant loosening. The aim of this project is to develop a computational tool that will be able to predict the mechanical performance of a cementless implant in the presence of uncertainty, for example through variations in implant alignment or bone quality. To achieve this aim, a computational model has to be developed and implemented. However, to gain confidence in the model, it should be verified experimentally. To this end, the present work investigated the behavior of a cementless implant experimentally, and compared the results with a computational model of the same test setup.

A synthetic bone (item 3406, Sawbones Europe AB, Sweden) was surgically implanted with a Furlong cementless stem (JRI, Sheffield, UK) in a neutral position and subjected to a compression fatigue test of -200 N to -1.6 kN at a frequency of 0.5 Hz for 50000 cycles. Measurements of the micromotion and migration were carried out using two linear variable differential transducers and the strain on the cortex of the femur was measured by a digital image correlation system (Limess Messtechnik & Software GmbH).

A three-dimensional model was generated from computed tomography scans of the implanted Sawbone and converted to a finite element (FE) model using Simpleware software (Simpleware Ltd, Exeter, UK). Face-to-face elements were used to generate a contact pair between the Sawbone and the implant. A contact stiffness of 6000 N/m and a friction coefficient of 0.3 were assigned. The analysis simulated a load of -1.6 kN applied to the head of the implant shortly post implantation. The motions and strains recorded in the experiment were compared with the predictions from the computational model. The micromotion (the vertical movement of the implant during a single load cycle), was measured at the proximal shoulder, at the distal tip of the implant and at the bone-implant interface. The maximum value calculated proximally using FE was 61.3 μm compared to the experimental value of 59.6 μm. At the distal end, the maximum micromotion from FE was 168.9 μm compared to 170 μm experimentally. As a point of reference, some authors have suggested that in vivo, fibrous tissue formation may take place at the bone-implant interface when the micromotion is above 150 μm. The maximum micromotion found computationally at this interface was 99 μm which is below the threshold value defined. The longitudinal strain over the surface of the bone was variable and reached values of up to 0.15% computationally and 0.4% experimentally; this may be related to the coordinate systems used. However, it was noted that digital image correlation identified qualitatively similar strain patterns, and has great potential for measuring low level surface strains on bone.

In conclusion, the good correlation between the computational modelling and experimental tests provides confidence in the model for further investigations using probabilistic analyses where more complex configurations (for example change in implant alignment) can be analyzed.
Uncemented porous-coated total hip prostheses rely on osseointegration or bone ingrowth into the 
poles for a stable interface and long term fixation. One of the criteria for achieving this is good initial 
stability, with failure often being associated with migration and excessive micromotion. This has 
particularly been noted for long stem prostheses. To minimize micromotion and increase primary 
stability, a short stemmed implant ‘PROXIMA’ (DePuy; Leeds, UK) with a prominent lateral flare 
was developed with the aim of providing a closer anatomical fit, more physiological loading and 
limiting bone resorption due to stress shielding. This study aims to simulate bone ingrowth and tissue 
differentiation around a well fixed porouscoated short stemmed implant using a mechanoregulatory 
algorithm and finite element analysis (FEA). Specific emphasis is made on the design of the implant 
and its effect on osseointegration.

An FE model of the proximal femur was generated using computer tomography (CT) scans. 
The PROXIMA was then implanted into the bone maintaining a high neck cut and adequate 
cancellous bone on the lateral side to accommodate the lateral flare and for osseointegration. A 
granulation tissue layer of 0.75mm was created around the implant corresponding to the thickness of 
the porous coating used. The mechanoregulatory hypothesis of Carter et al (J.Orthop, 1988) 
originally developed to explain fracture healing was used with selected modifications, most notably 
the addition of a quantitative module to the otherwise qualitative algorithm. The tendency of 
ossification in the original hypothesis was modified to 
simulate tissue differentiation to bone, cartilage or fibrous tissue. Normal walking and stair climbing 
loads were used for a specified number of cycles reflecting typical patient activity post surgery.

The majority of the tissue type predicted to be formed, simulating a month in vivo, is fibrous 
and indicates a weak interface proximally after this period. The stronger tissues, bone and cartilage 
occupy the mid-lower regions, indicating a strong interface distally. This can be explained by the 
unique lateral flare that provides extra stability to the distal regions of the implant, especially on the 
lateral side. The percentage of bone ingrown around the implant at different stages is also important 
and there was a significant rise from 15% after 10 cycles to about 30% after 30 cycles, simulating a 
month in vivo. It was also noted that initial bone formation was very high, even after a few cycles, 
which leads to a stronger interface early on. Fibrous tissue occupied around 45% at almost all stages 
and did not vary considerably. 
Cartilage however, was replaced by bone as tissue differentiation occurred, reducing from about 30% 
after 10 cycles to 20% after 30 cycles. This further indicates the trend of tissue ossification through 
the regions of stronger tissues, gradually proceeding in the direction of the weaker tissues.

The unique lateral flare design and the seating of the implant entirely in the cancellous bed 
without any diaphyseal fixation provides contrasting results in terms of bone ingrowth around the 
implant. The lateral flare minimises micromotion and provides better stress distribution at the 
interface under the region. This accounts for a large percentage of the mid to distal regions under the 
flare being covered with either bone or cartilage. From the predictions of the algorithm, the 
significant lateral flare of the PROXIMA helps in stabilizing the implant and provides better 
ossseointegration in the distal regions around the implant.
STRESS EVALUATION OF STEMLESS, ULTRA-SHORT AND SHORT STEM PROXIMAL FILL FEMORAL IMPLANTS

Over the last two decades, design modifications in cementless total hip arthroplasty have led to longer lasting implants and an increased success rate. However, there remains limitations to the cementless femoral stem implant. Traditional cementless femoral components require large amounts of bone to be broached prior to stem insertion (1). This leads to a decrease in host bone stock, which can become problematic in a young patient who may eventually require a revision operation during his or her lifetime. Osteopenia, only second to distal stress shielding can lead to aseptic loosening of the implant and stem subsidence, which also accelerates the need for a revision operation (2-4). Recent literature suggests that thigh pain due to distal canal fixation, micromotion, uneven stress patterns or cortex impingement by the femoral stem is directly correlated to increased stem sizes and often very disabling to a patient (5-8). In this study, we sought to determine whether reducing stem length in the femoral implant would produce more physiologic loading characteristics in the proximal femur and thus eliminate any remaining stress shielding that is present in the current design. We analyzed the surface strains in 13 femurs implanted with 1) no implants, 2) stemless, 3) ultra short and 4) short stem proximal fill implants in a test rig designed to assimilate muscle forces across the hip joints, including the ilio-tibial band and the hip abductors. Analysis of the resulting surface strains was performed using the photoelastic method. For each femur, intact and with the different stem length components in place, the fringe patterns were compared at the same applied loads. The highest fringe orders observed for all tests were located on the lateral proximal femur and medial proximal femur. The fringes decreased as they approached the neutral axis of bending (posterior and anterior). Distal fringe patterns were more prominent as the stem length increased. The results demonstrate that the stemless design most closely replicated normal strain patterns seen in a native femur during simulated gait. The presence of a stemless, ultra short and short stem reduced proximal strain and increased distal strain linearly, thereby increasing the potential for stress shielding. The stemless design most closely replicated normal strain patterns observed in a native femur and for this reason has the potential to address the shortcomings of the traditional cementless femoral implant.

References
A significant number of patients are affected by localised articular damage that is neither appropriate for traditional arthroplasty, nor for biological repair. A focal resurfacing system utilizing a matched contoured articular prosthetic (HemiCAP®) has been introduced for the treatment of such cases. Independent results on these implants are limited.

We retrospectively evaluated the use of this resurfacing system in 14 patients (13 male, one female), mean age 40.3 years (range 28-49) with focal femoral condyle defects. All procedures were performed by the same consultant orthopaedic surgeon. Clinical evaluation consisted of the Knee injury and Osteoarthritis Outcome Score (KOOS) assessment. Radiographic evaluation was conducted independently to look for signs of any migration of the prosthesis or any radiolucency around it.

10 patients were treated on the medial femoral condyle, two on the lateral, and two received bicondylar implants. Average follow-up was 20 months (range 6-42). All but two patients (no improvement) described a good to excellent response of their symptoms. The KOOS score at follow-up was 79.6, compared to 61.2 prior to treatment (p=0.03). No signs of device migration or radiolucency around the device were observed. None of the patients required re-operation, and there were no cases of superficial/deep infection, thrombo-embolic events or other significant complication.

Our short-term results demonstrate that the use of the joint preserving HemiCAP® system provides good pain relief and functional improvement in such patients.
MINIMALLY INVASIVE UNICONDYLAR HEMI-ARTROPLASTY: A 5 TO 9 YEAR FOLLOW-UP STUDY OF THE UNISPACER IMPLANT
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Long term clinical data and patient satisfaction is reported on 152 patients implanted with the UniSpacer interpositional spacer during the first four years of clinical use with a minimum 5-year, maximum 9-year follow-up. 156 UniSpacer™ Knee System implants were implanted in 152 patients (4 bilateral), for treatment of isolated medial compartment osteoarthritis over a 4-year period. The minimum follow-up for this group of patients is 5 years with a range of 60 to 108 months. Revisions to a TKR within one year of the implantation date during the first and second year of UniSpacer implantations were 6% and 5% respectively. By years three and four, the TKR revision rate within the first year had dropped to 0% (zero). The data reflects the improvement in surgical technique and the development of proper patient selection criteria. The long term data provides validation that the UniSpacerÔ can provide a successful, long term, bone preserving, treatment alternative to the current HTO, UKR or TKR procedures.
LARGE DIAMETER FEMORAL HEAD UNCEMENTED TOTAL HIP REPLACEMENT TO TREAT FRACTURED NECK OF FEMUR
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The aim of this study was to investigate the use of large diameter head THR to treat fractured neck of femur, and to demonstrate if this conferred greater stability.

Forty-six (46) independent, mentally alert patients with displaced intracapsular fractures underwent THR. Mean age was 72.1 years. Outcome measures were dislocation, reoperation/revision rate, Oxford hip score (OHS), Euroqol (EQ-5D) and residential status. Data was collected prospectively, with review being carried out at 3 months and 1 year.

At mean follow-up (12.5 months) there were no dislocations. Reoperation, revision and infection rate were all 0%. Two patients died (4.3%). Mean pre-injury and postoperative OHS were 12.1 and 17.9 respectively. Mean pre-injury and postoperative EQ-5D index scores were 0.97 and 0.83 respectively. Mean postoperative walking distance was 2.5 miles. There were no changes in residential status.

This is the first published series utilizing 36-mm diameter metal-on-metal THR for the treatment of fractured neck of femur. We have demonstrated that it affords patients excellent stability with no recorded dislocations.
COMMINUTED RADIAL HEAD FRACTURES: TO FIX OR REPLACE?
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The treatment of comminuted fractures of the radial remains controversial. When preservation of the radial head mechanics is required, the choice between open reduction and internal fixation and radial head replacement remains a difficult choice. Current literature does not provide guidelines but suggest that fracture complexity and technique are critical for success. We compared the outcomes of 30 patients who were treated with either open reduction and internal fixation or radial head replacements between 2005 and 2008.

Twenty six Mason type III and 4 Mason type IV fractures of the radial head were enrolled in the study. Twenty underwent open reduction and internal fixation (group I) and 10 underwent radial head replacements (group II). The mean age at operation was 37 and 49 years respectively and the duration of follow up 32 and 31 weeks respectively. The indications for radial head replacement were severe comminution, primary fracture dislocations and fracture dislocations with radial head excised. All patients were evaluated for pain, motion, strength, stability and function using the Broberg and Morley functional rating index.

Elbow range of motion averaged 9 degrees (extension loss) to 97 degrees (flexion in group I and 10 to 98 degrees in group II. Average pronation and supination were 71.5 and 72 (group I) and 69 and 74.5 (group II). The loss in strength in flexion, supination and pronation between the groups were not comparable (P>0.05). The Broberg and Morley functional rating score average was 81.9 (group I) and 82.2 (group II).

These results show that patients who were treated with open reduction and internal fixation did not have a significant advantage over patients who received radial head replacements in terms of range of motion, loss in strength and their functional rating score.
A914

INCREASED RISK OF PREOPERATIVE SEVERE BONE DEFECTS AND PERIOPERATIVE FRACTURES OF THE STEROID-LADEN RHEUMATOID PATIENTS UNDERGOING TOTAL HIP ARTHROPLASTY

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Aim: To ameliorate surgical strategy of disabled rheumatoid hip joints, perioperative status and clinical features of the patients undergoing total hip arthroplasty (THA) were retrospectively evaluated.

Materials and methods: 150 joints of 106 patients were studied (male/female rate; 1:6, mean age; 60 years and duration of the disease; 15 years). All patients received cemented THA (mean follow-up period; 8 years). Mode of bone defect with acetabular reconstruction type, femoral bone quality, survivorship, steroid use and complications were surveyed.

Results: In preoperative status, protusio acetabuli was found in 37% with type I; 54%, II; 34% and III; 12% by Sotelo-Garza classification. Superior bone defect was recognized in 56%, collapse and/or defect of femoral head in 19%, and geode formation in 0.2%. Femoral medullar canal was classified as type A; 1%, type B; 53% and type C; 46% by Dorr classification. The presence of fracture before surgery was 5%. Anatomical reconstruction was achieved in all cases including application of 42% bone grafting (autogenous alone; 51%, application of artificial substitute; 39% and of cross-plating system; 10%). Acetabular revision rate due to aseptic loosening (%/years) was improved by graft methods (whole series; 5/8, any grafting; 6/8, autogenous alone; 8/8, artificial substitute; 4/8 and cross-plate system; 0/4). Revision rate for any reasons was 9% (aseptic acetabulum 5%, aseptic femur 5%, dislocation 2% and infection 1%). Dislocation (11%), infection (3%) and severe thrombotic events (1%) were experienced. Steroid use was found in 73%, associated with increased risk of protrusio acetabuli, superior bone defect with protrusio acetabuli and fractures.

Discussion and Conclusion: The study indicated that steroidal medication significantly related to the perioperative status of bone defects and perioperative fractures of rheumatoid patients undergoing THA. Improved acetabular procedures could promise better survivorship of the implant.
ACCURACY OF ROBOTICALLY ASSISTED UKA
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Successful clinical outcomes following unicompartmental knee arthroplasty (UKA) depend on accurate component alignment, which can be difficult to achieve using manual instrumentation. A new technology has been developed using haptic robotics that replaces traditional UKA instrumentation. This study compares the accuracy of UKA component placement with traditional jig-based instrumentation versus robotic guidance.

85 UKAs performed using standard manual instrumentation were compared to 67 performed with a robotically guided implantation system without instrumentation. Each was performed using a minimally invasive surgical approach. The two groups were identical in terms of age, gender and BMI. The coronal and sagittal alignment of the tibial components were measured on pre- and post-operative AP and lateral radiographs. Postoperative tibial component alignment was compared to the pre-operative plan.

The RMS error of the tibial slope was 3.7° manually compared to 1.2° robotically. In addition, the variance using manual instruments was 9.8 times greater than the robotically guided implantations (p<0.0001). In the coronal plane, the average error was 3.0 ± 2.2° more varus using manual instruments compared to 0.3 ± 1.9° when implanted robotically (p<0.0001), while the varus/valgus RMS error was 3.7° manually compared to 1.8° robotically. The average depth of medial tibial plateau resection was significantly less with inlay tibial components (3.9 ± 0.9mm) relative to onlay tibial components (6.8 ± 0.9mm, p<0.0001). In addition, a significantly higher percentage of robotic inlay patients went home the day of surgery (12% vs. 1%, p<0.0001).

Tibial component alignment in UKA is significantly more accurate and less variable using robotic guidance compared to manual, jig-based instrumentation. By enhancing component alignment, this novel technique provides a potential method for improving outcomes in UKA patients.
Unicompartmental knee arthroplasty (UKA) is an increasingly attractive and clinically successful treatment for individuals with isolated medial compartment disease who demand high levels of function. A major challenge with UKA is to place the components accurately so they are mechanically harmonious with the retained joint surfaces, ligaments and capsule. Misalignment of UKA components compromises clinical outcomes and implant longevity. Cobb et al. (JBJS-Br 2006) showed that robot-assisted placement of UKA components was more accurate than traditional techniques, and subsequently that the clinical outcomes were improved. Cobb’s method, however, employed rigid intraoperative stabilization of the bones in a stereotactic frame, which is impractical for routine clinical use. Robotic systems have now advanced to include dynamic bone tracking technologies so that rigid fixation is no longer required. The question is - Do these robotic systems with dynamic bone tracking provide the same accuracy advantages demonstrated with robotic systems with rigidly fixed bones?

We compared robot-assisted and traditionally instrumented UKA in six bilateral pairs of cadaver specimens. In all knees, a CT-based preoperative plan was performed to determine the ideal positions and orientations for the implant components. Traditional manual instruments were utilized with a tissue-sparing approach to implant one knee of each pair. A haptic robotic system acting as a virtual cutting guide was used to perform the robot-assisted UKA, again with a tissue-sparing approach. Postoperative CT scans were obtained from all knees, and the 3D placement errors were quantified using 3D-to-3D registration of implant and bone models to the reconstructed CT volumes.

The magnitudes of femoral implant orientation error were significantly smaller for the robot-assisted implants compared to traditionally implanted components (4° vs 11°, p<0.001), but the magnitudes of femoral placement error did not reach significance (3mm vs. 5mm, p=0.056). The magnitudes of tibial implant placement error were not significantly different (4mm vs. 5mm and 7° vs. 7°, p>0.05).

Well-placed UKA implants can provide durable and excellent functional results, which is an increasingly attractive option for young and active patients with severe compartmental osteoarthritis who wish not to have or to delay a total knee replacement. Previous studies have demonstrated significant improvement in implant placement accuracy and clinical results with robot-assisted surgery using rigid bone fixation. This study demonstrates it is possible to achieve significant accuracy improvements with robot-assisted techniques allowing free bone movement. Additional larger trials will be required to determine if these differences are realized in clinical populations.
COMPARISON OF OSTEOARTHITIC KNEE PATIENTS ANALYZED IN VIVO WITH AND WITHOUT A KNEE BRACE DURING STEP UP AND STEP DOWN ACTIVITIES

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Many nonoperative techniques exist to alleviate pain in unicompartmental osteoarthritic knees including physical therapy, heel wedges and off-loading knee braces [1]. Arthritic knee braces are particularly effective since they can be used on a regular basis at home, work, etc. Previous knee brace studies focused on their ability to stabilize anterior cruciate ligament (ACL) deficient knees. A standard technique for analyzing brace effectiveness is the use of an athrometer to look at the range-of-motion. Although this is helpful, it is more useful to use X-ray or fluoroscopy techniques to analyze the in vivo 3-D conditions of the femur and tibia. One method for doing this is Roentgen Stereophotogrammetric Analysis, which uses a calibration object and two static X-rays to perform 3-D registration of the femur and tibia. This technique is limited to static and typically non-weight bearing analysis.

We have analyzed five patients with moderate to severe osteoarthritis in both step up and step down activities with two different knee braces and also without a knee brace. Fluoroscopy of the five patients performing these activities was obtained as well as a CT scan of the knee joint for each patient. 3-D models of the femur and tibia were obtained from manual segmentation and overlaid to the fluoroscopy images using a novel 3-D to 2-D registration method [2]. This allowed analysis of 3-D in vivo weight bearing conditions. This work builds off of an analysis where 15 patients were analyzed in vivo during gait with and without knee braces [3].

All five patients experienced substantially less pain when performing the step up and step down activities with a knee brace versus without a knee brace. It should be noted that none of the five patients were obese, which can limit brace effectiveness. Preliminary results show that medial condyle separation was increased by 1.4-1.6 mm when using a knee brace versus not using a knee brace during the heel-strike and 33% phases of step up and step down activities. Also, the condylar separation angle was reduced by an average of 1.5-2.5°. Finally, consistently less condylar separation was seen during step down versus step up activities (0.5-1 mm), which can be attributed to a greater initial impact force on the knee joint during step down versus step up activities.

Unicompartmental knee arthroplasty is realizing a resurgence due to factors such as improved alignment and sizing of components during surgery. This study compares the early results of two implantation techniques – robotic-assisted and standard manual alignment guides – to evaluate how a new technology developed to improve accuracy affects early patient outcomes.

For this study, we chose a prospective consecutive series of 20 patients in each group to receive a medial unicompartmental knee arthroplasty. The patients were evaluated clinically using standard outcomes measures (Knee Society, WOMAC and Oxford scores) as well as for modes of failure. Average follow-up for the manual onlay technique was 12 months and for the robotic-assisted inlay technique was and 10 months. Patients were not statistically different in terms of BMI, age, or diagnosis (p>0.05).

Knee society score (p=0.65), total WOMAC score (p=0.75) and Oxford knee score (p=0.88) were not statistically different between the three groups. Five patients in the robotic-assisted inlay group complained of persistent tibial pain that resolved in four patients. There were no revisions for the manual onlay implant group and there was one revision for persistent tibial pain in the robotic-assisted inlay group, consisting of a conversion to a standard manual onlay UKA tibial component.

Patient outcomes were similar with inlay robotic-assisted unicompartmental knee arthroplasty compared with conventional manual onlay implant techniques. Robotic-assisted inlay components resulted in slightly increased complaints of tibial pain and had one revision for tibial pain, however the revision was to a standard onlay UKA tibial component.
IN VIVO DETERMINATION AND CORRELATION OF KINEMATICS AND SOUND FOR SUBJECTS HAVING FOUR DIFFERENT CERAMIC-ON-CERAMIC THA.

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Previous clinical studies have documented the incidence of squeaking in subjects having a ceramic-on-ceramic (COC) THA. An in vivo sound sensor was recently developed used to capture sound at the THA interface. In this first study, it was determined that subjects having all bearing surface types demonstrated variable sounds. Therefore, in this follow-up study, the overall objective was to simultaneously capture in vivo sound and motion of the femoral head within the acetabular cup during weight-bearing activities for subjects implanted with one of four different ceramic-on-ceramic (COC) THA.

Twenty subjects, each implanted with one of four types of Ceramic-on-Ceramic THA (9 Smith and Nephew, 8 Stryker, 2 Wright Medical Technologies and 1 Encore) were analyzed under in vivo, weightbearing conditions using video fluoroscopy and a sound sensor while performing gait on a treadmill. Patients were pre-screened and two groups were defined: a group diagnosed as audible squeakers (9 THAs) and a control group of THA patients not experiencing audible sounds (11 THAs). Two tri-axial piezoelectric accelerometers were attached to the pelvis and the femoral bone prominences respectively. The sensors detect frequencies propagating through the hip joint interaction. Also, 3D kinematics of the hip joint was determined, with the help of a previously published 2D-to-3D registration technique. In vivo sound was then correlated to 3D in vivo kinematics to determine if positioning of the femoral head within the acetabular cup is an influencing factor.

For the audible group, two had a Smith and Nephew (S&N) THA, six a Stryker THA and one a Wright Medical (WMT) THA. Both of the S&N subjects, 5/6 Stryker and the Wright Medical subjects experienced femoral head separation. The maximum separation for those subjects was 4.6, 5.0 and 2.1 mm for the S&N, Stryker and WMT subjects, respectively. The average separation was 4.3, 2.0 and 2.1 mm for the S&N, Stryker and WMT subjects, respectively. For the eleven subjects in the control group, seven had a S&N THA, two a Stryker and one each having a WMT and Encore THA. All 11 of these subjects demonstrated hip separation with the maximum values being 3.8, 3.4, 1.9 and 2.4 mm for the S&N, Stryker, WMT and Encore THA, respectively. The average separation values were 1.8, 2.3, 1.9 and 2.4 mm for the S&N, Stryker, WMT and Encore THA subjects, respectively.

Four distinct sounds were produced by subjects in this study, which were squeaking, knocking, clicking and grating. Only 3/20 subjects produced a “squeaking” sound that was detected using our sound sensor. One of these subjects had a Stryker THA and two had a WMT THA. Further analysis of the nine subjects who were categorized as audible squeakers revealed that only 0/2, 1/6 and 1/1 subjects having a S&N, Stryker and WMT THA, respectively, demonstrated a squeaking sound that was detected using our sound sensor. Both (2/2) S&N subjects demonstrated a knocking and clicking sound, but neither produced a grating sound, while 5/6 Stryker subjects produced a knocking sound, but only 1/6 demonstrated a clicking or grating sound. Besides the squeaking sound, the only other sound produced by the WMT audible squeaker was a knocking sound. Only 1/11 control group subjects demonstrated a squeaking sound, which was a subject having a WMT THA. With respect to the control group subjects having a S&N THA, 5/7, 1/7 and 3/7 subjects produced a knocking, clicking or grating sound, respectively. Only 1/2 subjects having a Stryker THA produced a knocking or grating sound.

This is the first study to compare multiple COC THAs in analyzing correlation of femoral head separation (sliding) and sound. It was seen that all the THA groups had occurrences of separation and each case of separation correlated with the sound data. These results lead the authors to believe that the influence of squeaking is multi-factorial, and not necessarily attributed only to the bearing surface material.
THE NOISY HIP: ONLY IN CERAMIC-ON-CERAMIC BEARINGS?
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Background: Recently, the new phenomenon of “squeaking” noises emitted from THAs with ceramic-on-ceramic bearings has spared international interest. It shows a frequency of 0,7-19,5% in literature, but infrequently requires revision surgery. However, an even higher incidence of various other noises from those THAs audible to the human ear have become popular in the process: this noise can resemble clicking, grinding or creaking and can be caused by distinct movements, during longer periods of walking, or can be constant with movement. The incidence of those noises can reach up to 30% of THAs. However, memory has faded that other bearings like metal-on-metal and PE/ceramic have been associated with noises in the past.

Therefore we aimed to investigate the occurrence of acoustic emissions in patients, who had all received the same implant but with alternate bearings, to investigate the nature of noise, duration and clinical consequence for all 3 bearings (polyethylene/ceramic, metal-on-metal, ceramic-on-ceramic).

Method: Between 1999-2001, 360 patients were matched in a prospective randomised trial. All of them received a cementless Zimmer© Alloclassic Variall™ implant at the Orthopaedic Hospital Vienna – Speising, Austria with either a ceramic-on-ceramic bearing, a metal-on-metal bearing or a polyethylene/ceramic bearing. A questionnaire was sent via mail, including questions on first occurrence of hip noise, information on the kind and duration of the phenomenon and possible adverse evaluation on behalf of the patient. In case of a positive report, the patient was invited to a clinical examination and radiographic analysis. In addition, a specialised audiography was conducted in patients with audible sensations. Finally, the SF-36 and WOMAC were analysed. A number of patients received further examination with methods of gait analysis in order to detect the distinct point of occurrence of the noise during the gait cycle.

Results: 33 patients reported an audible phenomenon from their THA, 14 received a ceramic-on-ceramic bearing (Cerasul), 13 a polyethylene/ceramic bearing (Durasul) and 6 a metal-on-metal bearing (Metasul). The most common noise was a distinct clicking, followed by a creaking noise. Only 1 patient reported a squeaking sensation, he received a polyethylene/ceramic bearing.

Conclusion: The emission of specific noises from THAs of all bearings has been well documented in recent trials and could be verified in this survey of cementless THAs. No trend towards an increased incidence of noise from THAs with ceramic-on-ceramic bearings could be detected. Interestingly, the single case of „squeaking“ was reported from a patient with polyethylene/ceramic bearing. Microseparation and subluxation of the femoral head with resulting edge loading and formation of stripe wear has recently been suspected as the main cause for “noisy hips.” So far 2 ceramic-on-ceramic hips of this study group population have been revised. Both articulations showed areas of stripe wear due to subluxation of the joint.
Unicompartmental knee arthroplasty (UKA) is a logic procedure when osteoarthritis or avascular necrosis is limited to one femorotibial compartment. The indications for the procedure includes osteoarthrosis or osteonecrosis with full-thickness loss of articular cartilage limited to one of the tibiofemoral knee compartments. Physical examination should ensure full range of knee motion. Frontal and sagittal knee stability has to be tested. A particular attention should be given to the state of the anterior cruciate ligament. The status of the patellofemoral joint should be analysed by physical examination and patellofemoral view at 30, 60 and 90° of flexion. Preoperative anteroposterior varus and valgus stress radiographs should be done to confirm the complete loss of articular cartilage in the involved compartment, the full thickness cartilage in the opposite compartment and the possibility of full correction of the deformity to neutral.

The so-called minimally invasive surgery (MIS) procedure using a specific instrumentation is able to provide quicker recovery since the extensor mechanism disruption is eliminated. More importantly the radiological evaluation has shown that precise implantation of the components is possible with an MIS approach which is important for the long term results of the arthroplasty. The clinical results at ten years of follow-up of cemented metal-backed UKA performed through a conventional approach have shown results comparable to those obtained with total knee arthroplasty. The in vivo kinematic evaluation of patients implanted with UKA has shown that kinematics similar to the normal knee can be obtained, enhancing the importance of a functional anterior cruciate ligament.

Recent design improvements have increased the femorotibial area of contact to accommodate high flexion angles. Additionally our experience has demonstrated that modern UKA is a valid alternative for young and active patients with unicompartmental tibiofemoral noninflammatory disease, including both osteoarthritis and avascular necrosis. Compared to medial UKA lateral UKA represents in our experience only 5% of all UKA implantations. However the long term results of lateral UKA compares at least equally with those reported for medial UKA.
Metal-on-metal bearings have become popular in the last ten years because of a low wear rate combined with the ability to use large head sizes for conventional total hip arthroplasty (THA) and to facilitate resurfacing hip arthroplasty. Further advantages of metal-metal bearings include the fact that they are not at risk for fracture, and they can be made as modular or non-modular acetabular implants.

It was recognized early that metal-on-metal implants had the potential to increase serum ion levels, and this was demonstrated in a number of studies. The significance of elevated ion levels, however, for most patients has been primarily a theoretical concern of toxicity, carcinogenesis or mutagenicity, and to date very few, if any, systemic problems related to systemic metal ions have been documented with certainty. Nevertheless, most surgeons have avoided use of the implants in patients who are likely to become pregnant, patients with renal disease, or patients with major systemic illnesses which have a high likelihood of leading to renal disease. Furthermore, most have avoided using them in patients with known dermal metal allergies, even though the connection between dermal metal allergies and metal bearings has not been established.

Unexpectedly, an extremely important concern has emerged with metal bearings: the finding of local inflammatory reactions related to metal bearings. These inflammatory reactions can take several forms including pain with a milky effusion, local tissue necrosis, or large fluid collections or pseudotumors. The histology of these different reactions appears to be predominantly lymphocytic in nature and a term for at least some of these reactions has been coined “AVALS”. Whether these local reactions are primarily immunologic in nature or primarily related to dose of local metal ions or debris remains uncertain. While there is much still to be learned, it appears that certain patient populations may be at increased risk for metal reactions, possibly related to implant size (women and smaller patients). It also seems vertically oriented implants, which create edge loading, increase wear and increase risk of local metal reactions.

Perhaps the most important question is the incidence of local metal reactions, which remains to be defined. To date the problems in most series have been infrequent, less than 1 or 2 percent. However, in a few selected series the incidence has been higher, and when screening has been done for asymptomatic patients with fluid or masses around the joint, the rate has been higher in at least one reported series.

Surgeons may interpret the importance of local metal reactions differently, but certainly ultimately incidence of this problem will have a very major effect on the future of these bearings.
CERAMIC-ON-CERAMIC TOTAL HIP ARTHROPLASTY: MY EXPERIENCE
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The recent introduction of modern ceramic-on-ceramic total hip arthroplasties have demonstrated excellent clinical and radiographic results without catastrophic failure such as implant fracture associated with earlier designs. In laboratory wear testing, ceramic-on-ceramic provides the least volumetric wear among all bearing surfaces. In recent years, with modern ceramic-on-ceramic bearing surfaces, clinical results with 5- to 7-year follow up have been good to excellent in 95-97% of cases. In spite of excellent results, certain limitations still exist including occasional fracture, stripe wear, squeaking, and neck-socket impingement producing metallic third body. Future improvement in ceramics (and other hard-bearing surfaces) and its coupling with other hard bearing surfaces appears to have significant advantages in reducing dislocation, impingement, stripe wear and squeaking.
Ceramic on ceramic articulations had been used since 1970s but with high failure rate. More recent third generation alumina ceramic had improved results due to better material properties to resist wear and fracture and better methods of fixation with metal back acetabular components. A new clinical problem of squeaking has emerged in the last decade and is now a relatively common occurrence in ceramic on ceramic total hip arthroplasty, with a reported incidence from less than 1% to 20% depending on the definition of the noise. We report experience with over 3000 ceramic-on-ceramic hips including the 10 year minimum follow-up of the first 301 cases.

**Methods:** Between June 1997 and Feb 1999, 301 consecutive primary cementless hip arthroplasties were performed on 283 patients under the care of the two senior authors. The mean age of the patients was 58.

All patients are asked on follow-up as part of a questionnaire: Has your hip ever made a squeaking noise? To date of the more than 3000 ceramic on ceramic hips that we follow, 74 hips (71 patients) responded yes to this question. Patient demographic and outcome data were analysed in all squeaking hips and compared with all primary ceramic on ceramic hips operated on at our unit.

**Results:** Of the first 301 cases there have been 9 revision surgeries in 8 hips as follows. Two acetalular components revised for psoas tendonitis, one of these subsequently had both components revised for acetabular osteolysis with femoral revision to improve anteverision. There were six other femoral component revisions: four for periprosthetic femoral fractures, one for aseptic loosening and one for transient sciatic nerve palsy. There has been one squeaking hip in this group not requiring revision due to the mild and intermittent nature of the noise. All complications occurred within the first 3 years, no further complication has arisen since.

When comparing the 74 squeaking hips to the entire cohort of primary hips we found that taller, heavier and younger patients are significantly more likely to have hips that squeak. Squeaking hips have a significantly higher range of post-operative movement than silent hips. Squeaking hips have a significantly higher Harris hip score. There was no difference in the satisfaction scores between squeaking and silent hips.

**Conclusion:** In summary, we have reported the large series of third generation alumina ceramic on ceramic articulation with 10 year results, and have demonstrated that it can produce excellent survivorship with good clinical and radiographic outcome. We believe that this result had provided very encouraging evidence to support the use of third generation ceramics as articulation for primary hip arthroplasty, especially in young and active patients.
ACL RECONSTRUCTION DOES NOT IMPROVE THE SHORT TERM RESULT OF OXFORD MEDIAL UNICOMPARTMENTAL KNEE ARTHROPLASTY FOR ANTEROMEDIAL OA WITH SECONDARY RUPTURED ACL

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Good mid-term results of Oxford UKA (OxUNI) for anteromedial osteoarthritis (OA) were reported. The designers of prosthesis reported a 98% 10-year survival rate for a combined series of phase I and II, and these findings were supported by published results from other series, with 10-year survival ranging from 91% to 98%. In order to obtain good results, the designers of this prosthesis mentioned the importance of adhering to strict indication for OxUNI, especially only for OA cases with intact anterior cruciate ligament (ACL). OxUNI combined with ACL reconstruction (ACLR) is a viable treatment option for only young active patients, in whom the ACL has been primarily ruptured. On the other hand, it was not clear whether the result of OxUNI combined with ACLR for OA with secondary ruptured ACL was good. In this study we compare the short-term results of OxUNI combined with ACLR for OA with secondary ruptured ACL with that for usual OA with intact ACL.

382 OxUNI were performed at two hospitals by one surgeon between January 2002 and August 2005. Among those, 367 cases, followed over two years postoperatively (272 patients, women: 283, men: 84) were assessed. Follow up ratio was 96.1%. The mean patient age at the time of surgery was 72.0 (47~93) years. The mean follow-up period was 39.3 (24~67) months. Thirty three knees of OA were treated with OxUNI combined with ACLR, by using synthetic graft. Clinical results were assessed by the Oxford Knee Score (OKS) and active range of motion (ROM). Patients are asked a series of 12 questions, and their response scores range from 0 (worse) to 4 (best) for each, yielding an overall score range of 0-48. All living patients were contacted, and the status of the implant was established at the time of last follow from hospital records. We evaluate the survival rate for OxUNI with or without ACLR, using the endpoint of revision for any reason.

The pre- and postoperative clinical scores were compared using the paired Student’s t-test. Survivorship curves were constructed using the Kaplan-Meier method, and survivorship between groups was compared using logrank and Wilcoxon methods. All analyses were performed using 95% confidence intervals and a P value of <0.05 was considered significant.

The mean OKS at final follow-up was 42.1(preoperative; 21.7), and the mean active ROM was 125.2° (preoperative; 113.4°). OKS and active ROM were significantly improved. There were no significant differences in OKS and active ROM between OxUNI with ACLR and OxUNI with intact ACL. Fourteen knees among 367 knees were revised; nine for loosening of tibial component, four for dislocation of bearing and one for progression of lateral OA. Overall 5-year survival rate was 95.6%. When survival rate was assessed separately with or without ACLR, that of OxUNI with intact ACL was 96.7% and that of OxUNI with ACLR was 83.8%. There was significant worse survival rate between the two groups (P=0.0071).

The 5-year survival rate for OxUNI with intact ACL was 96.7%, which was equivalent to those of original series from Oxford. However, 5-year survival rate for Oxford UKA with ACLR was 83.8% in our series. Four knees in nine of loosening of tibial component were replaced by OxUNI combined with ACLR. Therefore, even if ACL was reconstructed, the results of OxUNI for OA with secondary ruptured ACL was proved to be pessimistic.

There was significantly worse survival rate for OxUNI with ACLR, compared with OxUNI with intact ACL. So we conclude that combined ACL reconstruction and OxUNI for anteromedial OA with secondary ruptured ACL is not recommended, which must be treated with TKA.
The performance of high flexion postures such as cross legged sitting, are not part of the assessment criteria to assess either function of a natural knee joint or after Total Knee Replacement (TKR) surgery, in assessment systems used by the orthopaedic fraternity today. This is probably because TKR was initially developed and widely employed in the western countries. However, increasing numbers of this surgery are being performed in the eastern parts of the world, comprising more than half of the global population, where postures such as cross legged sitting are a basic necessity of activities of daily living.

It has been a general perception that achieving flexion beyond 120 degrees after Total Knee Replacement surgery is not a routine result. The implant manufacturing industry has recognized this need and put implant designs on the market with accompanying literature which would suggest that the implant design itself contributes towards a higher range of movement post surgery.

We have performed a prospective study involving a hundred Total Knee Replacements using standard implants (PFC Sigma, Cruciate Sacrificing design, Depuy, J&J, NJ, USA). This implant is not supposed to be specifically designed to deliver a high range of flexion. We found that incorporating certain specific surgical steps as a standard part of the operative procedure delivers a high range of flexion greater than 135 degrees in seventy five percent of patients which allowed them to adopt the cross legged sitting posture after surgery.

This paper conveys the message that achieving a high range of flexion after surgery does not need any special implant design. It discusses the surgical steps which seem to contribute towards this result. The implications in terms of cost saving for health care system are immense.
Progression of osteoarthritis (OA) of the knee is related to alignment of the lower extremity. Postoperative lower extremity alignment is commonly regarded as an important factor in determining favourable kinematics to achieve success in total knee arthroplasty (TKA) and high tibial osteotomy (HTO). An automated image-matching technique is presented to assess three-dimensional (3D) alignment of the entire lower extremity for natural and implanted knees and the positioning of implants with respect to bone.

Sawbone femur and tibia and femoral and tibial components of a TKA system were used. Three spherical markers were attached to each sawbone and each component to define the local coordinate system. Outlines of the 3D bone models and the component computer-aided design models were projected onto extracted contours of the femur, tibia, and implants in frontal and oblique X-ray images. Threedimensional position of each model was recovered by minimizing the difference between the projected outline and the contour. The relative positions were recovered within $-0.3 \pm 0.5$ mm and $-0.5 \pm 1.1^\circ$ for the femur with respect to the tibia, $-0.9 \pm 0.4$ mm and $0.4 \pm 0.4^\circ$ for the femoral component with respect to the tibial component, $-0.8 \pm 0.2$ mm and $0.8 \pm 0.3^\circ$ for the femoral component with respect to the femur, and $-0.3 \pm 0.2$ mm and $-0.5 \pm 0.4^\circ$ for the tibial component with respect to the tibia.

Clinical applications were performed on 12 knees in 10 OA patients (mean age, 72.5 years; range, 62–87 years) to check change in the 3D mechanical axis alignment before and after TKA and to measure position of the implant with regard to bone. The femoro-tibial angle significantly decreased from $187.8^\circ$ (SD 10.5) to $175.6^\circ$ (SD 3.0) ($p=0.01$). The 3D weight-bearing axis was drawn from the centre of the femoral head to the centre of the ankle joint. It intersected significantly medial ($p=0.01$) and posterior ($p=0.023$) point at the proximal tibia before TKA. The femoral component rotation was $3.8^\circ$ (SD 3.3) internally and the tibial component rotation was $14.1^\circ$ (SD 9.9) internally. Compared with a CT-based navigation system using pre- and post-operative CT for planning and assessment, the benefit to patients of our method is that the post-operative CT scan can be eliminated.
We performed this study to evaluate the clinical and radiological results of metal on metal articulation change for the treatment of ceramic liner or head fractures in total hip arthroplasty (THA).

We retrospectively reviewed 8 patients with revision THA using liner cementation (metal on metal) due to ceramic fracture (liner fracture; 5 cases, head fracture; 3 cases). They were followed up for an average of 30 months (range 12 to 68 months). At the surgery, we removed ceramic liner and head, the joint cavity was irrigated with saline to remove remnants of ceramic particles. After that, the inner surface of the metal shell was roughened with a high-speed diamond burr to improve the fixation strength of the liner. Metal inlay polyethylene (Metasul®, Centerpulse Orthopedics, Austin, TX) liner was used and the back surface of the liner was routinely down sized and roughened like spider web with an electrical burr to ensure stable fixation with bone cement.

We evaluated clinical result using Harris Hip Score (HSS) and the Western Ontario and McMaster Universities Osteoarthritis index (WOMAC) score and radiological evaluation was done using the method of DeLee and Charnley for the acetabular osteolysis and method of Gruen et al. for the femoral osteolysis.

The mean Harris hip scores improved from 65.3 preoperatively to 93.8 at the final follow-up. There were no changes in cup position, no progression of osteolytic lesion around the femoral and acetabular components and no measurable wear of metal on metal bearing articulation at the last follow-up radiographs. There was one case of recurrent dislocation after surgery and the patient treated with greater trochanter distal advancement.

This study showed that for the treatment of ceramic liner or head fractures, after thorough removal of ceramic particles, cementation into a metal shell and changing the articulation to metal-on-metal provided good clinical and radiological results.
NOISE OCCURRENCE AFTER ALUMINA-ON-ALUMINA HIP ARTHROPLASTY
A SURVEY ON 284 CONSECUTIVE SURVEY ON 284 consecutive hips.
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Hard-on-hard bearing surface have been accepted as a valuable alternative for young and active patients needing a hip replacement because these combinations are resistant to wear. Initial development of alumina-on-alumina bearings faced complications such as fractures, and socket loosening. But, with the increasing number of prostheses implanted, noise occurrence appeared as a new complication. The primary aim of the present survey was to quantify the prevalence of having noise in a population receiving alumina-on-alumina hip arthroplasty.

Two hundred and eighty-four ceramic-on-ceramic hips were performed in 238 patients (126 males and 112 females) from January 2003 to December 2004. The average age at the index operation was 52.4 ± 13.4 years (range, 13 to 74 years). We used the same type of prosthesis for all patients manufactured in all cases by Ceraver-Osteal®. Clearance between femoral and insert was between 20 and 50 microns in order to achieve minimal wear. The survey was conducted by an independent surgeon who did not participated in patients care during the last 6 months of 2007. He interviewed the patients by phone with a standardized questionnaire (appendix) that aimed to assess if noise was present and the characteristics of this noise if present. No suggestion was done on how they could describe the noise and they felt free to use the word that they considered to be the most adapted. Satisfaction was evaluated asking if the patient was very satisfied, satisfied or dissatisfied with its prosthesis. When the noise was present, the X-ray was independently evaluated to assess if sign of component fracture was present.

Four patients (six hips) died of unrelated cause during the follow-up. Three patients (three hips) lived outside France and could not be followed (1.3%). Nine patients (ten hips) could not be traced and are considered lost to follow-up (3.8%). Two hundred and twenty-two patients with 265 hips were therefore surveyed. Among these 265 hips, 28 experienced noise generation (10.6%). It was defined as a snap for 6 patients, as a cracking sound by 6, as rustling by 6 patients, as a squeaking by 7 patients (2.6%), a tinkling by 2 patients, one patient was unable to define the sound she felt. No factor related to the patient influenced the occurrence of noise. Twelve patients were dissatisfied with the result of the hip prosthesis, 5 of them experienced noise (41.7%); 210 were satisfied or very satisfied 23 of them experienced noise (11%); this difference was significant (p=0.002). No patients required revision for noise.

The origins of noise occurrence are unknown but several hypotheses can be suggested. Squeaking may be due to absence of sufficient lubrication. Other types of noise can be due to microseparation, occult dislocation, impingement between the femoral neck and the acetabular rim but demonstration remain an issue.
STATISTICAL DETERMINATION OF THE FEMORAL NECK ISTHMUS AND ITS IMPLICATIONS FOR OPTIMAL NECK AXIS ALIGNMENT

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In the light of the increasing popularity of femoral resurfacing implants, there has been growing concern regarding femoral neck fracture. This paper presents a detailed investigation of femoral neck anatomy, the knowledge of which is essential to optimise the surgical outcome of hip resurfacing as well as short hip stem implantation.

Three-dimensional lower limb models were reconstructed from the CT-scan data by using the Mimics (Materialise NV, Leuven, Belgium). We included the CT data for 22 females and nine males with average age of 60.7 years [standard deviation: 16.4]. A local coordinate system based on anatomical landmarks was defined and the measurements were made on the unaffected side of the models.

First, the centre of the femoral head was identified by fitting an optimal sphere to the femoral head surface. Then, two reference points, one each on the superior and the inferior surface of the base of femoral neck were marked to define the neck resection line, to which an initial temporary neck axis was set perpendicular. Cross-sectional contours of the cancellous/cortical border were defined along the initial neck axis. For each cross-sectional contour, a least-square fitted ellipse was determined. The line that connects the centre of the ellipse at the base of the femoral neck and the centre of the femoral head was defined as the new neck axis. The above process was repeated to reduce variances in the estimation of the initial neck axis. The neck isthmus was identified according to the axial distributions of the cross-sectional ellipse parameters. The short axis of the ellipse decreased monotonically since it was calculated from the center of the femoral head to the neck resection level (base of neck), whereas the long axis changed with the local minima. The cross section at which the long axis of the fitted ellipse had the local minima was determined as the neck isthmus.

The following measurements were made on the proximal part of the femur. The neck axis length measured from the center of the femoral head to the lateral endosteal border of the proximal femur was 67.3 mm [6.4]. The length between the center of the femoral head and the neck isthmus was 22.5 mm [2.7]. The diameter of the ellipse long axis at the neck isthmus was 27.6 mm [3.5] and was 23.6 mm [3.3] for the short axis. The center of the neck isthmus did not align with the neck axis. The deviation of the isthmus from the neck axis which we defined as the isthmus offset was 0.7 mm [0.4].

If an alternative neck axis was defined between the center of the femoral head and the center of the neck isthmus, there would be a certain degree of angular shift with respect to the original neck axis. An angular shift of 1.8 degrees between the two axes can be expected for a 0.7-mm isthmus offset. In the worst case, an angular shift of 4.59 degrees was estimated for a subject with the largest isthmus offset of 1.93 mm.

Further investigations would be necessary to determine the axis configuration that represents the clinically relevant centre of the femoral neck. In order to reduce the deviations in the three-dimensional determination of the femoral neck axis, the reference anatomical landmarks and methods of evaluation should be carefully selected.
Multiaxial rotation of femoral component is generated in a wide range against UHMWPE tibial insert during ambulation or deep bending activities. Simultaneously, microscopic oscillation and twisting might accompany with such a wide-range motion. Such a combined in-vivo kinetics is expected to bring more severe wear to the sliding surface of knee joint prostheses than that in a case of single macro-kinetics (i.e., that commonly reproduced by conventional wear simulators). In order to reproduce clinical surface degradation correctly and quantitatively in simulator tests, we have to consider microscopic motions at the joint bearing surfaces. The purpose of this study is to analyze the influence of the composite knee motion on wear using a non-destructive spectroscopic approach.

The crystalline phase in UHMWPE is pre-oriented in the tibial insert from the manufacturing process, but the orientation of crystalline lamellae is sensitive to mechanical loading. Therefore, the orientation of the crystalline lamellae on the surface of retrieved UHMWPE tibial inserts could reflect the local motions in vivo generated in the joint during ambulation. The visualization of (orthorhombic) crystalline lamellae might ultimately lead to the possibility of tracking back the wear history of the joint. In this study, polarized Raman spectroscopy was employed in order to non-destructively visualize the lamellar orientation in UHMWPE tibial inserts, which were retrieved after exposures in human body elapsing several years.

According to this Raman analysis and in comparison with an unused insert, the orientation of surface lamellae was found to have been clearly changed due to wear in accordance to the local motion of the femoral component. Additionally, we could obtain information about the origin of delamination from the in-depth profile for lamellae orientation angle. This study not only shows the possibility of optimizing the UHMWPE structure to minimize wear but also gives a hint for the development of knee simulators of the next generation.
Balancing the PCL in a PCL-retaining total knee replacement (TKR) is important, but sometimes difficult to execute in an optimal manner. Due to the orientation of the PCL it is conceivable that flexion gap distraction will lead to anterior movement of the tibia relative to the femur. This tibio-femoral repositioning influences the tibio-femoral contact point, which on its turn affects the kinematics of the TKR. So far, the amount of tibiofemoral repositioning during flexion gap distraction is unknown which leads to uncertain kinematic effects after surgery. The goal of this study was to quantitatively describe the parameters of the flexion gap (gap height, anterior tibial translation and femoral rotation) and their relationship while the knee is distracted during implantation of a PCL-retaining TKR with the use of computer navigation. Furthermore, the effect of PCL elevation angle on the flexion gap parameters was determined.

In 50 knees, during a ligament-guided TKR procedure, the flexion gap was distracted with a double-spring tensor with 100 and 200 N after the tibia had been cut. The flexion gap height, anterior tibial translation and femoral rotation were measured intra-operatively using a CT-free navigation system. PCL elevation was calculated based on the femoral and tibial insertion sites as indicated by the surgeon with the pointer of the navigation system. To identify a relationship between flexion gap height increase and anterior tibial translation, the ratio between anterior translation and gap height increase was determined for each patient between 100 and 200 N.

The mean gap height increased 2.2 mm (SD 0.96) and mean increase in anterior tibial translation was 4.2 mm (SD 1.6). Hence, on average, for each mm increase in gap height, the tibia moved 1.9 mm (SD 0.96) in anterior direction. Knees with a steep PCL showed significantly more AP translation for each mm gap height increase (gap/AP-ratio was 1 : 2.31 (SD 0.63)) compared to knees with a flat PCL (gap/AP-ratio was 1 : 1.73 (SD 0.50)). The increase in femur (exo)rotation was on average 0.60º (SD 1.4).

With a tensioned PCL the tibia will move anteriorly on average 1.9 mm for every extra mm that the flexion gap is increased. The flexion gap dynamics can be explained in part by the orientation of the PCL: the greater the elevation angle, the more anterior tibial displacement during distraction of the flexion gap. The surgeon must be aware that distraction of the flexion gap influences the tibio-femoral contact point. The tibio-femoral contact point will move posteriorly and stresses in the PCL will rise and produce limited flexion and pain. In case of a conforming insert AP-movement will be limited but high PE stresses may be introduced that can lead to wear. This information may be helpful in selecting the optimal soft tissue balancing procedure and the optimal PE insert thickness in PCL retaining TKR.
IN VITRO LYMPHOCYTE ASSAY FOR HYPERSENSIVITY TO METALS DURING THE FIRST TWO POSTOPERATIVE YEARS USING TWO DIFFERENT RESURFACING HIP ARTHROPLASTIES
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A major concern in metal on metal bearings has been the elevated serum concentrations of cobalt and chromium. Recent papers have suggested that metal hypersensitivity in a few cases could cause periprosthetic lymphocyte accumulation leading prosthetic loosening.

To measure the lymphocyte activation and proliferation in vitro by re-exposure of the cells to cobalt, chromium, nickel and titanium. To correlate the lymphocyte assay data to the serum concentration of metals and plasma cytokines.

A prospective clinical study with the ASR (DePuy) and ReCap (Biomet) resurfacing hip implants. Blood samples were collected one and two years postoperatively, lymphocytes were isolated by density gradient centrifugation, cultured in a medium containing the patient’s serum and exposed to metal salts. Cells were analyzed by flow cytometry, evaluating number, viability, size and CD69 activation. A negative control and a positive control (phytohaemagglutinine) were included in the assay, and the responses to the metals were calculated in proportion to controls. 11 patients were assessed at one and two years follow up, 16 patients were assessed only at two years. Serum chromium and cobalt were measured preoperatively, six months, one year and two years postoperatively by graphite furnace absorptiometry. Plasma cytokines were measured by multiplexed immunoassay.

In the assay the negative and positive controls gave the expected responses. When exposed to metals no response was found in the lymphocytes in any patients. There were no difference in response between one and two years.

The results seems to indicate that the metal hypersensitivity is a rare condition in metal on metal arthroplasty. The results indicate that the method can be used to monitor hypersensitivity to implant metals.
A COMMON REFERENCE FRAME FOR DESCRIBING ROTATIONAL ALIGNMENT OF THE DISTAL FEMUR
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The understanding of rotational alignment of the distal femur is essential in total knee replacement to ensure that there is correct placement of the femoral component. Many reference axes have been described, but there is still disagreement about their value and mutual angular relationship. Our aim was to validate a geometrically-defined reference axis against which the surface-derived axes could be compared in the axial plane. A total of 12 cadaver specimens underwent CT after rigid fixation of optical tracking devices to the femur and the tibia. Three-dimensional reconstructions were made to determine the anatomical surface points and geometrical references. The spatial relationships between the femur and tibia in full extension and in 90° of flexion were examined by an optical infrared tracking system.

After co-ordinate transformation of the described anatomical points and geometrical references, the projection of the relevant axes in the axial plane of the femur were mathematically achieved. Inter- and intra-observer variability in the three-dimensional CT reconstructions revealed angular errors ranging from 0.16° to 1.15° for all axes except for the trochlear axis which had an interobserver error of 2°. With the knees in full extension, the femoral transverse axis, connecting the centres of the best matching spheres of the femoral condyles, almost coincided with the tibial transverse axis (mean difference –0.8°, SD 2.05). At 90° of flexion, this femoral transverse axis was orthogonal to the tibial mechanical axis (mean difference –0.77°, SD 4.08). Of all the surfacederived axes, the surgical transepicondylar axis had the closest relationship to the femoral transverse axis after projection on to the axial plane of the femur (mean difference 0.21°, SD 1.77). The posterior condylar line was the most consistent axis (range –2.96° to –0.28°, SD 0.77) and the trochlear anteroposterior axis the least consistent axis (range –10.62° to +11.67°, SD 6.12). The orientation of both the posterior condylar line and the trochlear anteroposterior axis (p = 0.001) showed a trend towards internal rotation with valgus coronal alignment.
CERAMIC HIP SQUEAKING: VIBRATION ANALYSIS OF RETRIEVED HIPS TO IDENTIFY THE SOUND SOURCE
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Squeaking of ceramic-on-ceramic (CoC) hips is a clinical phenomenon that is concerning with regard to the long term performance of these joint devices. Investigations into the cause of the squeaking have focused on patient factors and demographics, surgical placement, and other non-ceramic components in the devices. The current study tests latest-generation CoC devices to measure the vibration modes and frequencies of the components individually as well as assembled in the complete surgical construct.

Audio data from clinical cases of squeaking hips were analysed to determine the frequencies present. Retrieved CoC hips (n = 7) and never-implanted CoC bearing couples (n = 3) were tested in the laboratory for squeaking under loaded articulation. Bovine serum was introduced into the CoC articulation and dried to promote stick-slip motion at the articulation. Squeaking sounds from the in vitro tests were recorded for audio analysis. Low mass, high frequency-response ceramic shear piezoelectric accelerometers (PCB Piezotronics) were adhered to the hip components along multiple axes to measure vibrations during testing.

Clinical audio shows that squeaking occurs at fundamental frequencies in the range of 1 to 3 kHz, with harmonics above the fundamental frequency. Retrieved CoC bearing couples squeaked at fundamental frequencies from 1.5 kHz to 3.8 kHz. Fourier Transform analysis of the audio closely matched the concurrent output from the accelerometers mounted directly on the ceramic components. This held true even in the absence of metal components in the system. With metal components included in the test construct (acetabular shell, acetabular cup, femoral stem), those components also vibrated at the same frequencies as the ceramic bearing couples, indicating that the CoC articulation is the source of the vibrations, with metal components conducting and emanating the sound.

The never-implanted bearing couples were made to squeak and vibrated at fundamental frequencies ranging from 1 kHz to 8 kHz.

Squeaking from CoC hips can be reproduced in the lab using components from clinical retrievals. Instrumentation of the explanted hips confirms that the vibration frequencies of the ceramic components themselves match the audible squeaking. The squeaking of ceramic components mounted with soft polymers and with no metal contact at any point indicates that the ceramic components themselves are the source of the clinical squeaking. The measured vibration of ceramic components in the audible range is an observation not predicted by modeling studies reported in the literature to date.
COMPUTER ASSISTED SURGICAL NAVIGATION (CASN) IN THE KNEE USING STRESS TESTS TO ASSESS TIBIO-FEMORAL STABILITY AND PATELLAR TRACKING.

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Controversy still exists in the literature regarding efficacy and usefulness of CASN in knee arthroplasty. However, obsession with basic alignments and proper correction of mechanical axes fails to recognise the full future potential of CASN which seems to lie in enhanced dynamic assessment. Basic dynamics usually at least includes intraoperative assessment of limb alignments, flexion-extension gap balancing and simple testing through ranges of motion. However our upgraded CASN system (Brainlab) is also capable of enhanced assessment not only including the provision of data on initial to final alignments but also contact point observations. The system can also perform an enhanced ‘Range Of Motion’ (ROM) analysis including observation of epicondylar axis motion, valgus and varus, antero-posterior shifts as well as flexion and extension gaps. Tracking values for both tibiofemoral and patellofemoral motion have also been obtained after performing registration of the prosthetic trochlea. Observations were then made using a set of standardised dynamic tests. Firstly, the lower leg was placed in neutral alignment and the knee put through a flexion-extension cycle. Secondly the test was repeated but with the lower leg being placed into varus and internal rotation. The third test was performed with the lower leg in valgus and external rotation.

We have been able to carry out these observations in a limited case series of 15 total knee arthroplasties and have found it possible to observe and quantify marked intra-operative variation in the stability characteristics of the implanted joints before corrections have been made and final assessments performed. Indeed contact point observation has found several cases of edge loading before corrections have been made. Also ROM analysis has demonstrated the ability of the system in other cases to observe and then make necessary adjustments of implant positions and ligament balance which alter the amounts of antero-posterior and lateral translations. In this way paradoxical antero-posterior and larger rotational movements have been minimised. Cases where conversion to posterior stabilisation has been necessary have been encountered. Also patellar tracking has been observed during such dynamic tests and appropriate adjustments made to components and soft tissue balancing.

Although numbers in this case series are small, it has been possible to begin to observe, classify and quantify patterns of instability intra-operatively using simple stress tests. Such enhanced intra-operative information may in future make it possible to create algorithms for logical adjustments to ligament balance, component sizes, types and positions. In this way CASN becomes a more useful tool.
A common feature of retrieved ceramic-on-ceramic (CoC) hips is the presence of metal transfer on the femoral head. This metal transfer represents an important change in the articulating surface and can have consequences in terms of lubrication, friction, wear, and squeaking. Given the potential impact of metal transfer on the performance of CoC bearing couples, a good understanding of the factors surrounding its occurrence is warranted. This study documents the metal transfer onto a ceramic femoral head with two subluxations onto the rim of the cup which occurred during surgery. This metal transfer is compared to that on other ceramic heads retrieved for various reported reasons, including squeaking, pain and loosening.

The first ten retrieved alumina heads of current ceramic technology (Ceramtec, Plochingen, Germany) submitted to our retrieval laboratory were assessed to document the phenomenon of metal transfer. Nine devices underwent in vivo service (mean duration 32 mo., range 13 to 84) and the tenth device was removed intra-operatively and serves as an instructive control case. It was impacted onto a trunnion and during final testing for stability subluxed anteriorly over the titanium lip of the cup. The metal transfer was immediately noted by the surgeon and the head was removed.

All ceramic heads were examined under light microscopy (Nikon Dissecting Microscope, Tokyo, Japan) and white light optical profilometry (NewView 7300, Zygo, Middlefield, CT).

The control ceramic head showed two distinct metal transfer streaks from two discrete subluxation events that were documented by the surgeon (IMT). Those streaks are aligned in a direction approximately 24° to the right (clockwise) of a line through the polar apex of the head and parallel to the axis of the femoral neck. Microscopy and profilometry indicate that they were laid down in a direction from equator-toward-pole. Seven of the retrieved ceramic heads showed streaks of metal transfer that are very similar to those on the control ceramic head in terms of: alignment (equator-toward-pole, 20 to 45° off-axis) width (tapered point growing to approximately 1.0 to 1.5 mm), depth of metal deposition (0.25 to 0.40 μm), and depositional texture.

It is notable that the metal transfer streaks commonly observed on retrievals bear a close resemblance to that caused by a single intra-operative event wherein a hip abduction force pulled the head into contact with the titanium cup/liner rim. An important implication is that this demonstrates that metal transfer can occur with a single instance of rim contact, wherein the femoral head is forced against the metal cup rim. If metal transfer onto the head were to occur during final reduction of the hip, its presence may well be undetected and any deleterious in vivo impact of the metal transfer would be in effect from the day of surgery.
Objective: Unicompartmental knee arthropasty (UKA) has recently attracted increased popularity and usage, though issues exist regarding tibial component failure. UKA instability may be due to insufficient bony support at the proximal tibia. Pre-operative knowledge of ‘safe’ resurfacing depths offering subchondral bony support could help minimize UKA instability. We recently developed a novel CT imaging tool (CT-TOMASD) which assesses subchondral bone mineral density (BMD) in relation to depth from the subchondral surface. The objective of this work was to determine the in-vivo precision of CT-TOMASD safe resurfacing depths in human tibial compartments.

Seven knees from seven donors (2M:5F; age:46+/−11) were scanned three times via QCT (GE Lightspeed; BMD Phantom; 0.625x0.625x0.625mm resolution). CTTOMASD regional analyses were performed for medial and lateral compartments; outputting density versus depth plots fit with polynomial regression equations. As density decreases with increased depth from the subchondral surface, a density threshold of 300mg/cm3 was arbitrarily set to correspond with the safe resurfacing depth. The 300mg/cm3 density threshold corresponds to the average density of subchondral trabecular bone, and is ~2x the density of weak epiphyseal trabecular bone located beneath stiffer subchondral trabecular bone. Precision was defined using coefficients of variation (CV%).

In-vivo precision errors associated with CT-TOMASD safe resurfacing depths were less than 2.7%. CV% was 2.7% for the medial compartment depth and 2.6% for the lateral compartment depth.

CT-TOMASD demonstrates repeatable measures of safe resurfacing depths invivo. Safe resurfacing depths are measured in relation to defined density thresholds which can be adjusted according to UKA design and patient specifics (e.g., size, sex). CT induces a low radiation dosage due to the low presence of radiosensitive tissues at the knee (~1/10th of a long-leg standing radiograph). CT-TOMASD has potential to be used as a pre-operative imaging technique for improved UKA stability and longevity.
Several anatomical landmarks are preferable in order to achieve the precise decision of femoral component rotation in order to achieve a satisfying result in total knee arthroplasty (TKA). The posterior condylar axis (PCA) is apparent and allows minimization of interobserver error compared with the transepicondylar axis or anterior-posterior axis. The rotation angle based on PCA observed during surgery differs from the angle measured on pre- and postoperative epicondylar view, because X-rays do not reflect the posterior condylar cartilage. We investigated the influence of the posterior condylar cartilage on setting the rotation angle of the femoral component in 184 knees in 112 patients with varus osteoarthritis undergoing TKA.

Medial and lateral thickness of the resected posterior femoral condyle was measured before and after removing the cartilage to determine its thickness. The amount of rotation angle influenced by the cartilage is expressed as an inverse trigonometric function (arctangent) of the distance between the posterior condylar surfaces and the difference in thickness between the medial and lateral cartilage.

Average thickness of the lateral and medial cartilage turned out to be $2.1\pm0.7\text{mm}$ and $0.7\pm0.7\text{mm}$, respectively. The average rotation angle influenced by this difference was calculated to be $1.7\pm1.3^\circ$. These findings suggest that using PCA as a guide to determine the rotation angle of the femoral component results in approximately $1.5-2.0^\circ$ of excess external rotation in varus osteoarthritis. Because of significant individual variability in condylar twist angle, formed by the intersection of the clinical epicondylar axis with the PCA, preoperative CT or epicondylar view is recommended in order to calculate this angle in each subject. Thickness of the posterior condylar cartilage should be taken into consideration when finalizing the rotation angle of the femoral component by PCA in addition to trans-epicondylar and anterior-posterior axis.
OUTCOME OF CERAMIC-CERAMIC TOTAL HIP ARTHROPLASTY IN PATIENTS YOUNGER THAN 50 YEARS.
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Patients who are less than 50 years old at the time of total hip arthroplasty (THA) have been known to have higher failure rates than patients who are older. Wear-induced osteolysis and associated component loosening is the most common mode of failure reported. The current investigation prospectively assessed the survivorship and clinical results of alumina ceramic-ceramic THA in patients younger than 50 years.

238 consecutive hips in 201 patients treated by alumina ceramic-ceramic THA were studied. The mean age at operation was 41.4 ± 7.5 years (range, 18 – 50 years). The preoperative Merle d’Aubigné score was 11.1 ± 1.6 (6 – 15). The preoperative diagnosis included primary osteoarthritis or impingement (105 hips, 44%), developmental dysplasia of the hip (90 hips, 38%), osteonecrosis of the femoral head (17 hips, 7%), posttraumatic osteoarthrosis (16 hips, 7%), and rheumatoid arthritis (6 hip, 3%). 144 hips (61%) were replaced with the use of surgical navigation for acetabular component positioning. The mean cup diameter was 51.8 ± 3.7 (range, 46 – 60 mm). 73 (31%) bearings were 28 mm and 165 (69%) bearings were 32 mm.

At mean follow-up of 5.6 ± 2.3 years (2 – 11 years), the mean Merle d’Aubigné score was 17.4 ± 0.9 (14 – 18). There were no radiographic signs of osteolysis. There were two revisions (0.8%): one for acute cup displacement and one for a ceramic liner fracture. In addition, one hip was treated by I&D for acute infection and another with I&D but without evidence of infection. Other complications included one greater trochanter fracture and one calcar fracture, both repaired at surgery, and one transient peroneal nerve palsy. The 10-year Kaplan Meier survivorship of the implants (revision of any component for any reason) was 98.7% (95% confidence interval 96.3-100%). There were no hip dislocations.

Results of THA in patients less than 50 years using alumina ceramic-ceramic bearings at two to eleven years follow-up are promising with no case of osteolysis or dislocation.
EFFECTS OF TIBIAL INSERT SLOPE ON POLYETHYLENE WEAR

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A tibial insert with choices in posterior slope, size, and thickness is proposed to improve ligament balancing in total knee arthroplasty. However, increasing slope, or the angle between the distal and proximal insert surfaces, will redistribute ultra-high molecular weight polyethylene (UHMWPE) thickness in the sagittal plane, potentially affecting wear. This study used in-vitro testing to compare UHMWPE wear for a standard cruciate-retaining (CR) tibial insert (STD) and a corresponding 6° sloped insert (SLP). Our hypothesis was that slope variation would have little effect on wear.

Two of each style inserts were tested on an Instron-Stanmore knee simulator with a force-control regime. The gait cycle and other settings followed ISO 14243-1 & 2, except for the reference position, which was posteriorly shifted 6 mm to simulate the worst-case scenario. The STD insert was tilted 6° more than the SLP to level the articular surfaces. Wear was gravimetrically measured at intervals according to strict protocol.

No statistical difference (p=0.36) was found between wear for the STD (9.5 ±1.8 mg/Mc) and SLP (11.4 ±0.5 mg/Mc) inserts.

The overall wear rate measured was higher than previously published rates using implants similar to the STD inserts. This may relate to the shift in the reference position and the 6° slope, leading to increased shear loads. This is the first time the effect of tibial insert slope on wear has been evaluated in-vitro. When limited to 6°, wear testing suggests that altering the tibial insert slope will have a minor effect on UHMWPE wear.
A higher than expected failure rate of the Zimmer Durom acetabular component has been reported. A study by Zimmer did not reveal a design defect. This study investigated impaction deformation of two cup designs.

Eleven Durom cups and modular heads (Zimmer, Warsaw, IN) were retrieved at an average of 13.9 months. The Birmingham Hip Resurfacing (Smith & Nephew, Memphis, TN) served as a control. Cups were impacted into a two-point acetabular loading model made of 30 grade urethane foam (Sawbones, Vashon, WA). A coordinate measuring machine with 2 micron (um) accuracy was used to map the inside diameters of the cups before, during and after impaction. Machinist’s dye was used to check head-cup contact.

The Durom porous coating was essentially devoid of tissue ingrowth. Two heads used with size 62/56 Duroms had equatorial wear stripes. The outside diameter of the Durom was 2.93±0.03mm larger than the nominal diameter. Dome wall thickness was 3.23±0.07mm for the Durom and 6.08±0.65mm for the BHR (n=11). Inside diameters of all cups had less than 10um deviation from roundness before impaction and after removal from the model. The mean diametral deformation of the Durom was 89.8±14.8um, significantly greater than the BHR, 57.2±25.0um (p<0.002). Non-impacted cups exhibited polar contact—circular areas of dye at the dome with no contact near the rim. Duroms with greater deformation exhibited linear contact—a 2cm band of dye extending from rim to rim with no contact on either side of the band.

The Durom is a relatively thin-walled acetabular component with low clearance and an aggressive rim flare. Impaction of this cup into an acetabular model resulted in deformation which approached the diametral clearance. Maximal deformation with larger cups and warping of the articular surface correlated with observed wear stripes. The absence of residual cup deformation indicated deformation is a dynamic phenomenon which can be detected only under conditions simulating in vivo use. It is likely that impaction deformation, with consequent friction and wear, contributed to the early failure of the Durom acetabular component.
DOES GENDER EXPLAIN THE VARIABILITY OF PATELLO-FEMORAL MORPHOLOGY OBSERVED IN TKR
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Several studies have suggested that, in TKR, gender specific-prostheses are needed to accommodate anatomic differences between males and females. This study was performed to examine whether gender is a factor contributing to the variability of the size, shape and orientation of the patellofemoral sulcus.

3D computer models of the femur were reconstructed from CT scans of 20 male and 20 female femora. The patellofemoral groove was quantified by measuring landmarks at 10 degree increments around the epicondylar axis. The orientation of the groove was defined by the tracking path generated by a sphere moving from the top of the groove to the intercondylar notch. To assess the influence of gender on the shape of the distal femur, all morphologic parameters were normalized for differences in bone size.

Overall, the distal femur was 15% larger in males compared to females. The male condyles were 4% wider than the female for constant AP depth (p=0.13). When normalized for bone size, there was no gender difference in most patello-femoral dimensions, including the length, width, angle or tilt of the sulcus. Female femora had a less prominent medial anterior ridge (p=0.07), and a larger normalized radius of curvature of the tracking path (p=0.03). In addition, the orientation of the sulcus differed by 1-2 degrees in both the coronal and axial planes. Overall, gender explained 4.7% of the anatomic variation of the parameters examined, varying from 0 to 15.9%.

The size, shape and orientation of the patello-femoral groove are highly variable. While the patello-femoral morphology of male and female femora are very similar, some of the anatomic variability is related to gender, particularly the prominence of the medial ridge and the sulcus radius of curvature. The biomechanical and clinical significance of these differences after TKA have yet to be determined.
COMPUTED TOMOGRAPHY-BASED NAVIGATION FOR PLACEMENT OF THE ACETABULAR COMPONENT IN TOTAL HIP ARTHROPLASTY FOR SEVERE ACETABULAR DEFORMITY
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The position of the acetabular component affects the result of total hip arthroplasty (THA) in terms of postoperative dislocation, impingement, wear etc. However, as it is much difficult to place the component in the appropriate position for the cases of severe acetabular deformity, we used a Computed tomography (CT)-based navigation for THA in such cases. Therefore, the purpose of this study was to estimate the accuracy of a CT-based navigation in terms of acetabular component positioning in THA for severe acetabular deformities.

13 patients (1 man, 12 women), 14 hips underwent THA using a posterolateral approach with a CT-based navigation. The diagnoses were severe developmental dysplasia (Crowe group III, IV) in 6, ankylosis in 3, destructive arthritis after infection in 2, Charcot joint, and arthrodesed hip. And, we evaluated the differences of component position from the center of the anterior pelvic plane (APP), anteversion angle, and inclination angle relative to APP between the intraoperative data from the navigation system and the data from postoperative CT. Considering the intra-observer error, the measurement was done three times respectively and the mean value was accepted. We also estimated the difference between the component size planned and that implanted.

The mean difference between intraoperative records and actual postoperative results of the component position shows 3.3 mm (range: 0-7.0, SD: 2.2) for the horizontal position, 3.2 mm (range: 0-9.7, SD: 4.5) for the vertical position, 4.4 mm (range: 2.0-7.7, SD: 1.6) for the antero-posterior position from the center of the APP, 1.3 degrees (range: 0-3.0, SD: 0.9) for the inclination and 2.9 degrees (range: 0.3-8.3, SD: 2.2) for the anteversion respectively. All components were placed in the safe zone by Lewinnek. The component size was predicted in 10/14 (71.4%) hips. There were no complications related to the use of the navigation.

This study showed the accuracy of cup positioning using a CT-based navigation in THA for the cases of severe acetabular deformity. We concluded that this system was a useful tool for surgeon to identify orientation, implant acetabular component at the precise position and angle, and to reduce the incidence of some complications especially for patients with these severe acetabular deformities.
TKR IN PATIENTS WITH GONARTHROSIS SECONDARY TO FEMORAL OR TIBIAL MALUNION: A REVIEW OF 34 CASES
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Introduction: In patients with gonarthrosis secondary to a femoral or a tibial mal union, the technical problems are different according to the localization and the importance of the deformity, the presence of boneless, the cutaneous and ligamenteous status and the degree of preoperative motion.

Material Methods: Between 1995 and 2003, 34 TKR have been performed in patients with mal unions either post trauma (26 cases) either secondary to surgery (osteotomy with hypercorrection). There were 21 males and 13 females. The average age was 63 years (38 to 77). The mal union was localized to the femur (9 cases) or the tibia (23 cases) or to the both femur and tibia (2 cases). The deformity was variable: varus, valgus, flessum, recurvatum or rotationnal mal union. IKS scoring, HKA, MFA and MTA angles were evaluated pre and post operatively. 11 cases of intra articular mal unions, secondary to epiphyseal fractures were operated: a TKR posterostabilized (9 cases) or constrained (2 cases) was performed. In the extra articular mal unions (23) the technique depended on the degre of intraosseous deformity: medial or lateral release or osteotomy performed when the intra osseous deformity was more than 10°. TKR was associated with an osteotomy in one time surgery in 5 femoral mal unions and 12 tibial deformities.

Results: The average follow up was 8 years (4 to 13 years). Complications consisted in 5 phlebitis, 2 superficial skin necrosis, 4 stiff knees (flexion less than 80°). There was no infection in this short serie. The average IKS score was 65 before and 163 after operation. The average flexion was 83° preoperatively and 98° after surgery. Average HKA angle was 167° pre and 182° post operatively in the varus deformities. In the valgus deformity it was 191° pre and 181° post surgery.

Discussion: Average IKS scoring is less good in post traumatic mal unions than in the habitual TKR specially because of the motion: the knee is often stiff preoperatively and remain often stiff postoperatively. A quadriceps release is sometimes indicated either during the TKR either in a second time. Constrained implants (constrained condylar knee or rotating hinge) are necessary in some cases of medial or lateral insuffisency of the collateral ligament.
The purpose of this prospective study was to investigate the necessity of gender-specific design in total knee arthroplasty (TKA) for Korean women.

One hundred and seventeen women (151 knees) who underwent primary TKA by one surgeon with Nexgen® LPS (Zimmer, Warsaw, IN) were evaluated. The mean age was 70 (range 52-80) years. The size of the implant was determined by considering anteroposterior (AP) dimension and the amount of posterior condylar resection. Size C was used in 72 knees, size D in 57 and size E in 22. We measured the medio-lateral (ML) widths of distal femur at four points (anterior, distal anterior, distal posterior, posterior) intraoperatively after bone cutting, and compared them with the ML widths of the corresponding femoral implants. The ML/AP ratio was calculated in each size group.

The mean ML widths of the distal femur checked at all four points were larger than those of the implants. The ML/AP ratio of the distal femur decreased as the size increased from C to E, especially that of the anterior point. Overhanging occurred in 7 cases (4.6%, size C - 2 cases, size D - 2 cases, E - 3 cases) : Nexgen® LPS implant was used in 5 cases because there was only minimal antero-lateral overhanging, resulting in no postoperative problem such as pain or limited motion. Gender-specific design was used in only 2 cases (1.3%, size D - 1 case, size E - 1 case) with trochlear dysplasia due to general overhanging.

In conclusion, gender-specific design of Nexgen® TKA was rarely necessary in 117 Korean women (151 knees); overhanging occurred in 7 knees (6 women) and gender-specific design was used in only two knees (1.3%) with trochlear dysplasia. Further research is obviously mandatory to assess the necessity of gender-specific design.
ACCURACY AND REPRODUCIBILITY OF POSTERIOR SLOPE ALIGNMENT IN PRIMARY TOTAL KNEE REPLACEMENT USING EXTRA-MEDULLARY TIBIAL JIGS AND COMPUTER NAVIGATION
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Posterior slope of the tibial component is an important factor in overall alignment of Total Knee Arthroplasty. The purpose of this study was to compare the accuracy and reproducibility of tibial bone cuts utilizing traditional extra-medullary 0 degree and angled 5 degree cutting blocks, and computer aided navigation, in primary total knee arthroplasty.

We identified 3 groups of patients. Group one were primary total knees performed using an extramedullary 0 degree cutting block for posterior slope, group 2 were performed using an extramedullary 5 degree cutting block and the third group were performed with computer navigation. Patients in all 3 groups were age and sex matched. All operations were performed by residents or clinical fellows, under the supervision of the senior authors. Lateral digital radiographs were reviewed and posterior slope was determined in a standardized fashion. Two independent blinded researchers assessed the posterior slope using Siemens Magicweb software version VA42C_0206.

The average difference from the ideal posterior slope in navigated knees was lower than with non-navigated knees, however this was not significant (p=0.086). The average difference from the ideal posterior slope in computer navigated knees was 1.77 degrees (95% CI=1.28 to 2.26) compared to 2.37 degrees (95% CI=1.56 to 3.17) with the 5 degree cutting block and 2.70 degrees (95% CI=1.73 to 3.66) with the 0 degree block. No absolute significant difference was highlighted between the 3 groups using ANOVA testing (p=0.22).

All three techniques used to obtain ideal tibial slope were accurate. Accuracy was not increased by the use of computer navigation; however navigation resulted in less variation in outcome. The two jig based methods produced similar outcomes and either technique can be used successfully.
MORPHOMETRIC MEASUREMENTS OF RESECTED SURFACE OF FEMURS IN KOREAN KNEES: A CORRELATION TO THE SIZING OF CURRENT TKR IMPLANTS
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Purpose: The purpose of the study is to measure the resected surface of femur of the Korean patients during total knee arthroplasty surgery and to compare these measurements with the dimensions of femoral implants in current use.

Materials and Methods: Morphometric data (7 parameters) were obtained in 500 cases of resected femur of the Korean patients who underwent total knee arthroplasties, and these data were compared with four current implants designs.

Results: The range of medial-lateral width at the given implant varies widely. The anterior width of the resected femur at the condyle is smaller than the widths of the most implants, creating an overhang. The medial-lateral width of the condyle at the level of transepicondylar line is wider than most of the present implants. However the widths of the resected posterior condyles were narrower at anterior-posterior alignment, causing overhang at the posterior condyles. We felt this will cause anterior tensioning at flexion and reduce the ability to flex further.

Conclusion: The shape of the femur in Korean knee is different from that of current TKR implants in use, which are based on the anthropometric data of Caucasians. Therefore new design, better suited to the morphometric measurements of Korean knee, is necessary. Though historically this mismatch of the implant was well tolerated, new design to better fit the measurement of Korean knee should be considered for functional enhancement such as range of motion, durability and function.

Key words: Morphometric measurements, resected femur, total knee arthroplasty.
EFFICACY OF COMPUTER NAVIGATION IN TOTAL KNEE ARTHROPLASTY
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Total knee arthroplasty (TKA) has become one of the most successful procedures in orthopedics, and its survival rates are reportedly greater than 90% after 15 years. Malpositioning of the component, however, can lead to various failures, such as aseptic loosening, instability, polyethylene wear, and patellar dislocation. Navigation systems for TKA have been developed to improve postoperative alignment. Many clinical and experimental studies of these navigation systems have shown that the accuracy of implanted components has improved.

We have compared the alignment of 150 total knee replacements implanted using a computed tomography-based navigation system and using the conventional alignment guide system when performed by a single surgeon. The knees were evaluated using full-length weight-bearing anteroposterior radiographs and computed tomography scans. For the navigated group, the average hip-knee-ankle angle, the femoral component angle to the femoral mechanical axis, and the tibial component angle to the mechanical tibial axis were 179.5, 89.4 and 89.7 degrees. The rotational femoral and tibial component angles to the planning axis were 0.6 and 0.3 degrees. The ideal angles of all alignments in the navigated group were obtained at significantly higher rates than in the conventional group. Our results demonstrated significant improvements in component positioning with CT-based navigation system, especially with respect to rotational alignment.

Recently, we established a new method for 3D reconstruction from postoperative CT images in order to accurately measure the alignment of the component relative to any designed plane. The results showed that the discrepancy between the two-dimensional and three-dimensional evaluations was 0.3 ± 1.8 (−2.7−3.4) degrees. The coronal femoral angle for 36 knees (97.3%) and the coronal tibial angle for all the 37 knees (100%) were obtained within 3 degrees from the optimal angle. It is possible to measure the postoperative alignment for TKA more accurately on the basis of the defining plane. Three-dimensional analysis is necessary to evaluate the accuracy of the navigation system.

We conclude that navigation system is a very useful tool for achieving proper postoperative alignment. Controversy still exists regarding accuracy in rotational alignment with image-free navigation, but our results showed that CT-based system significantly improved accuracy of rotational alignment. We should keep using and improving the systems to establish more simplified and accurate systems.
Introduction: Wound Hemarthrosis remains a major concern following TKA. This prospective study evaluates the use of a knotless interlocking suture system and its relationship to wound appearance and OR efficiency.

Methods: Two groups of patients undergoing TKA in our institution were evaluated using two different wound closure techniques. Group I consisted of twenty five patients who underwent standard closure using interrupted vicryl for the arthrotomy, deep fascia, superficial fascia, followed by staples. Group II consisted of twenty five patients who underwent closure using three separate running barbed sutures (Quill, Angiotech Inc) – first for the arthrotomy, followed by deep fascia, subcuticular and staples. We compared closure times, drain output and postoperative day to achieve zero wound drainage on the dressings.

Results: Closure times for Group II averaged 10 minutes faster than Group I. Drain output was decreased in the barbed suture cohort. Wounds achieved zero drainage, on average, one day sooner in Group II and no patients were returned to the OR for hematoma evacuation or arthrotomy disruption.

Conclusions: Use of this new technique for closure of TKA incisions can lead to faster operative times, lower drainage outputs and less immediate postoperative wound drainage. It appears that hemostasis is obtained quicker with the use of this barbed suture system while at the same time while maximizing OR efficiency.
Revision total knee replacement (TKR) is a challenging procedure, especially because most of the standard bony and ligamentous landmarks used during primary TKR are lost due to the index implantation. One might also assume that the conventional instruments, which rely on visual or anatomical alignments or intra- or extra-medullary rods, are associated with significant higher variation of the leg axis correction, especially in cases with significant bone loss which prevents to control the exact location of the usual, relevant landmarks. Navigation system might address this issue.

We are using an image-free system (ORTHOPILOT TM, AESCULAP, FRG) for routine implantation of primary TKR. The standard software was used for revision TKR. Registration of anatomic and cinematic data was performed with the index implant left in place. The components were then removed. New bone cuts as necessary were performed under the control of the navigation system. The size of the implants and their thickness was chosen after simulation of the residual laxities, and ligament balance was adapted to the simulation results. The system did not allow navigation for intra-medullary stem extensions and any bone filling which may have been required. 60 navigated cases were compared with 30 conventional cases.

We observed a significant improvement of all radiological items by navigated cases. Limb alignment was restored in 88% of the navigated cases and 73% of the conventional cases. The coronal orientation of the femoral component was acceptable in 92% of the navigated cases and 81% of the conventional cases. The coronal orientation of the tibial component was acceptable in 89% of the navigated cases and 73% of the conventional cases. The sagittal orientation of the tibial component was acceptable in 87% of the navigated cases and 71% of the conventional cases. Overall, 78% of the implants were oriented satisfactorily for the four criteria for navigated cases, and only 58% for conventional cases.

The navigation system enables reaching the implantation goals for implant position in the large majority of cases, with a rate similar to that obtained for primary TKA. The rate of optimally implanted prosthesis was significantly higher with navigation than with conventional technique. The navigation system is a useful aid for these often difficult operations, where the visual information is often misleading.
TOTAL KNEE ARTHROPLASTY WITH AND WITHOUT COMPUTER NAVIGATION: REAL ADVANTAGES IN A PROSPECTIVE RANDOMIZED CONTROLLED STUDY

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Several authors have reported that Computer-Assisted Surgery (CAS) can improve limb and prosthesis alignment and ligament balancing in total knee arthroplasty (TKA) and permit the use of a less invasive surgical procedure. This can have a positive impact on the time of recovery of patients. In order to evaluate the real impact on the final outcome of CAS in TKA, we conducted a prospective control study comparing the outcome of computer-assisted and conventional TKAs.

We analyzed 60 primary TKAs, randomly divided into two cohorts - group 1 = STD (standard instrumentation) and group 2 = CAS - over three consecutive years. Both cohorts included 30 cases, all affected by primary knee osteoarthritis. The same model of prosthesis was implanted in all cases, by one surgeon, using the same surgical technique. Two patients were bilateral: in both cases one side was treated with standard instrumentation and the other with CAS. We conducted a clinical evaluation at the pre-operative moment and at the consecutive Follow-Up (FU), using the American Knee Society Score (AKSS). We scored patient satisfaction using the Oxford and the Ranawat Center questionnaire. We also recorded the main intra-operative data, such as total blood loss, surgical time, tourniquet time, Range of Motion (ROM). Finally, we performed a radiological study analyzing the pre-operative and consecutive FU radiographs to obtain a quantitative evaluation of limb and prosthesis alignment.

The intra-operative blood loss was higher in patients of group STD, with an average difference of 127 ml, statistically significant (p = 0.0283). Component position was acceptable for all implants, but the mechanical axe error of the CAS group was (1.00 +/- 0.20) degrees, significantly less than that of the STD group (2.10 +/- 0.50) degrees. The mean coronal femoral alignment was 90.00 degrees (range, 89 -92 degrees) in the CAS group, and 91.00 degrees (range, 88 -93 degrees) in the STD group. The operating time of the CAS group was longer than that of the STD group, with an average time difference of 26 minutes, statistically significant [ P = 0.005]. The AKSS and the Oxford and the Ranawat Center questionnaire analysis revealed a faster rehabilitation and an earlier return to daily life activities in the CAS group, independent of the preoperative level of disability.

We conclude that the use of navigation in TKA increases accuracy in limb and implant alignment and improves the rehabilitation phase. By achieving more reliable artificial joint implantation, CAS can improve prosthesis duration and joint function. It, however, needs more operating time.
STEM FIRST METHOD WITH BIG METAL HEAD WILL DECREASE THE RATE OF DISLOCATION AFTER PRIMARY TOTAL HIP REPLACEMENT


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Dislocation following total hip arthroplasty is one of the most common complications, occurring in 1% to 5% of all cases. Several causes for dislocation have been suggested that 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 much more flexible. Since July 2005, stem first method has been applied for all cases. During this method, canal preparation and stem trial was done first, and then cup orientation was determined according to the stem direction and impingement. For the bigger cups 34mm or 38mm heads were applied in this series. In the present study dislocation ratio was compared to cup first method.

In the stem fist group (SF), the following procedures were done consequently. 1) Canal was prepared for the stem. Revelation lateral flare high proximal load transfer stem (DJO) was mainly selected. But for the case with high anteversion over 50 degrees, Modulas; conical distal load transfer stem with modular neck (Lima) was selected. 2) According to the stem anteversion and neck length, cup position and orientation were determined. (For the cases with higher anteversion, less cup anteversion was selected, and for some cases higher cup position was selected.3) According to the cup size 28, 34, or 38 mm diameter neck was selected.

From October 2002 to July 2008, there were 191 THA cases. There were 81 hips in Standard group and 109 hips in SF group. There were 63 females and 18 males in Standard group and 90 females and 19 males in SF group (p=0.41). Average age was 61.0(22-81) in Standard group and 60.2(29-89) in SF group (p=0.53). In Standard group, 64 were replaced for osteoarthritis, 15 for rheumatoid arthritis and two for avascular necrosis. In SF group, 86 were replaced for osteoarthritis, 17 for rheumatoid arthritis and six for avascular necrosis (p=0.53). As for Crowe’s classification, 61 type I, 18 type II and 2 type III were included in Standard group. And 88 type I, 15type II, 4 type III and 2 type IV were included in SF group (p=0.29). Average anteversion of femoral neck were 23.1(-2 to 70) degree in Standard group and 26.2(-4 to 65) degree in SF group measured with CAT scan (p=0.274). MoM bearing surfaces were used with 71 hips (87.7%) in Standard group and 100 hips (91.7%) in SF group (p=0.35). Only in SF group, big metal head were used in 24hips(22%) with 34mm and in 12hips(11%) as 38mm diameter. Average leg length difference between pre and post operation was 11.5mm(0 to 36) in Standard group and 8.0mm(-18 to 30) in SF group (p<0.05). Average cup inclination was 43.2(25 to 84) degree in Standard group and 40.9 (22 to 66) degree in SF group (p<0.05). Average cup anteversion was 8.2 degree (0 to 22.8) in Standard group and 7.1 degree (-12 to 30.5) in SF group (p<0.05). Average operating time was 111.9min (67-150) in Standard group and 97.5min(60-162) in SF group (p<0.05). Average intra operative hemorrhage was 744ml(10-2757) in Standard group and 487ml(10-1374) in SF group (p<0.05). The dislocation rate was decreased from 3.7% (3/81 cases) in Standard group to 0.0% (0/109) in SF group.

In conclusion our study suggested that Stem first method and utilization of big metal head would decrease the dislocation rate in primary cases. More bleeding from canal during acetabular reaming was expected. However less bleeding was observed in SF group.
PREVENTION OF VENOUS THROMBOEMBOLISM ASSOCIATED WITH FONDAPARINUX ADMINISTRATION FOLLOWING HIP SURGERY IN JAPANESE PATIENTS

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On the basis of observations made in recent years, it can be inferred that the incidence of venous thromboembolism (VTE) in Japan is as high as that in Western countries. Since 2007, the use of fondaparinux for the prophylaxis of VTE following lower-limb orthopedic surgery has been approved for Japanese patients. This study was performed with an aim to investigate the safety and efficacy of fondaparinux for the prevention of VTE following hip surgery in Japanese patients.

From June 2007 to August 2008, we evaluated 141 consecutive patients (148 hips; average age, 65.6) undergoing total hip replacement (THR), consisted of cementless minimally invasive surgery, and hip fracture surgery (HFS), consisted of open reduction and internal fixation or bipolar hemiarthroplasty. We mainly used 2.5 mg of fondaparinux for a period extending up to 14 days. We estimated the symptomatic VTE and asymptomatic deep-vein thrombosis (DVT) rates in patients by ultrasonography performed on preoperative and postoperative day 3. In addition, we evaluated the preoperative and postoperative plasma D-dimer levels on days 3, 7, and 14.

We determined that both the preoperative and postoperative incidence of symptomatic VTE was 0%. A D-dimer value of 20 ug/ml or higher was not observed on preoperative days 3 and 7; however, this value was observed in 2 hips on postoperative day 14. The incidence of asymptomatic DVT was observed to be 0.8% preoperatively and 4% postoperatively. In particular, the corresponding value following HFS was observed to be 7.7% preoperatively. The incidence of the hemorrhagic event was observed to be 14.9%. Bleeding was mostly observed in the surgical and drainage areas. An overall major bleeding incidence of 0.7% (1 patient) was observed. The corresponding value in patients in whom the administration of fondaparinux was discontinued by day 14 was 18.9%.

The study results indicate that fondaparinux is useful in Japanese patients for the prevention of VTE following hip surgery. However, the administration of this drug should be accompanied by additional measures to prevent the associated side effect of bleeding.
SURGICAL IMPACT OF USING A GENDER SPECIFIC TOTAL KNEE PROSTHESIS
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Introduction: Gender specific total knee prostheses have been developed and one expected outcome of a prosthesis that fit normal anatomy better would be the need for fewer soft-tissue releases at the time of implantation. The purpose of this study was to report any change in the frequency of soft-tissue maneuvers between a standard versus a gender based TKA design.

Methods: Using the same surgical technique, 568 consecutive primary cruciate retaining TKAs were performed by the author. Only female patients are reported. 258 received a Standard design and 160 received a Gender TKA design. Both groups were statistically evaluated for diagnosis, height, weight, body mass index (BMI), knee alignment, range of motion (ROM), total Knee Society Score (KSS), and the KSS pain component score. Intra-operative parameters including all soft-tissue releases and component sizes were recorded.

Results: There was a significant decrease in lateral retinacular release utilization (p < 0.001) and overall soft-tissue releases (p < 0.002) when using the Gender TKA. There was also a significant shift in the size of femoral components used away from smaller Standard TKA femoral components. (p < 0.001). There was no change in the use of the polyethylene insert thickness (p = 0.368).

Discussion: Acceptance of femoral component design limitations may adversely affect the outcome of primary TKA. The use of a prosthesis that better reproduces female anatomy decreased the need for soft tissue “adjustments”. Additionally a larger size of femoral components was used. This requires less bone resection and may lead to better knee kinematics with a more normal posterior femoral offset. It is concluded that this design change improves operative technique of total knee replacement by requiring fewer releases in female patients.
COMPUTER ASSISTED TOTAL KNEE ARTHROPLASTY FOR SIGNIFICANT TIBIAL DEFORMITY
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Computer Assisted Total Knee Arthroplasty (CAS TKR) has been shown to provide excellent and reproducible limb mechanical alignment. CAS TKR has also been demonstrated to reduce limb alignment variance and outliers. Previous studies have shown improved mechanical alignment both radiographically and clinically. Specifically, CAS TKR has been shown to result in alignment deviations less than 3 degrees from neutral mechanical femoral and tibial axes. Furthermore, CAS TKR also permits any significant pre-operative tibial deformity to be quantified prior to performing tibial osteotomies. In this study, we describe the use of computer navigation to quantify the amount of bone loss on the medial or lateral tibial plateau and the subsequent use of this data to assess the need for augmentation with tibial wedges.

Two hundred and thirty consecutive primary computer assisted total knee arthroplasties were performed by one senior surgeon (L.P.) at Northwestern Memorial Hospital. In all cases, the tibial deformity was quantified and recorded intraoperatively using computer navigation software. The deformity was recorded in the navigation software by inputting the lowest point on the deformed tibial plateau and the mid point on the non-deformed tibial plateau using navigation markers. After Institutional Review Board approval was obtained, a retrospective review of the patient operative reports and patient charts was performed. Operative reports were reviewed to identify cases with the difference between the values of medial and lateral tibial plateaus exceeded thirteen millimeters and cases when tibial augmentation was performed. In cases utilising medial or lateral tibial augmentation, pre operative and post operative anterior posterior and lateral knee radiographs and long leg standing anterior posterior radiographs were reviewed to measure the joint line restoration and final mechanical limb alignment.

All two hundred and thirty operative dictations and patient charts were reviewed. In seven cases, the difference between the values of the medial and lateral tibial plateaus was greater than thirteen millimeters. In all seven cases, tibial augmentation was utilized in order to prevent resection of tibial bone in excess of fourteen millimeters. In cases with a difference of medial and lateral tibial plateau values of less than thirteen millimeters, no tibial augmentation was utilised. For the seven cases using tibial augmentation, preoperative and post-operative knee and long standing radiographs were reviewed to examine joint line restoration and final limb alignment. In all seven patients, joint line restoration was successful within 4 millimeters and long standing radiographs revealed excellent limb alignment.

Computer Assisted Total Knee Arthroplasty has already been shown to provide excellent limb alignment and reduce variance and outliers. We demonstrate that Computer Assisted Total Knee Arthroplasty in patients with significant tibial deformities can help assess and the amount of bone loss on the medial or lateral tibial plateaus. Excessive tibial resection to restore the mechanical axis and joint line can be avoided by quantifying the amount of tibial bone loss prior to osteotomy. Thus, Computer Assisted Total Knee Arthroplasty can successfully restore the joint line and overall limb alignment with conservative bone resection in patients with significant pre-operative tibial deformities.
We have been operating TKA for the deformity of OA and RA knee using OrthoPilot kinematic navigation system manufactured by Aesculap (Germany, Tutulingen) since 2005. It has the technology of ligament balance check capability, of which intra-operative registration is not so troublesome and also has the guidance system to achieve the correct bony cutting to the mechanical axis. Although we only have short-term results so far, we have evaluated our results and made some observations. We have 151 cases at our institution composed of 114 OAs and 37 RAs, with 29 males and 122 females. Among them, 95 cases were able to follow-up over one year. Limited only to three cases, we had to discontinue the usage of this system due to the loosening of the rigid body during surgery, which we had to change the maneuver to use manual instrument.

The average age at the time of surgery was 73.8 years (range, 38 to 90), and the average BMI was 24.5 (range, 15.6 to 37.7). The average femoral axis, which is the angle between the femoral mechanical axis and the femoral joint surface in the coronal plane, was 2.06 degrees (range, -9 to 10). The average pre-bone-cutting tibio-femoral axis was -8.04 degrees (range, -31 to 15), which after implantation became -0.18 degrees (range, -6 to 6). Tibial proximal cutting has to be perpendicular to the mechanical axis of the lower leg in the coronal plane. The average tibial medial cut was 1.61mm (range, 8 to -11) and tibial lateral cut was 6.78mm (range, 15 to -2). This difference of about 5mm indicates that the shape of tibia had varus deformity to the mechanical axis of the lower leg. On the femoral side, the average femoral medial cut was 9.72mm (range, 19 to 1) and femoral lateral cut was 8.23mm (range, 16 to 1). This almost identical cutting thickness indicates that there was almost no deformity to the mechanical axis on the femoral side. The final X-ray in the follow up period had not changed from the post-operative one. There was no change in VAS comparison three months post-operative.

The results of this study seem to indicate that the kinematic navigation system for TKA will lead to good results of patients’ satisfaction and long durability even for OA and RA knees.
EFFECT OF LOADING AND SERUM PROTEINS ON THE FRICTIONAL PROPERTY OF VITAMIN E-CONTAINING ULTRAHIGH MOLECULAR WEIGHT POLYETHYLENE
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It have been reported that the wear volume of vitamin E-containing UHMWPE tested with a knee joint simulator was approximately 30% lower than that of virgin UHMWPE at 5 million cycles. However, the wear resistance mechanism of vitamin E-containing UHMWPE has not yet been clarified. The present study examines the effects of the addition of vitamin E on the frictional properties of ultra-high molecular weight polyethylene (UHMWPE) under several different load and serum conditions.

Friction tests were carried out using a computer-controlled pin-on-disk friction test apparatus. The UHMWPE pin was mounted vertically at the tip of the leaf spring and linear reciprocating sliding motion for 2,000 cycles with an amplitude of 1 mm and a frequency of 1 Hz, was applied under 3 MPa or 30 MPa loading against Co-28Cr-6Mo alloy disk. The lubricant bath was filled with 5 ml of ultrapure water, fresh serum, post-friction (PF) serum or diluted-PF (DPF) which were kept at a temperature of 37°C. The friction force between the UHMWPE pin and the Co-28Cr-6Mo alloy disk was calculated from the displacement of the leaf spring during the sliding motion.

Vitamin E-containing UHMWPE showed a significantly higher friction force than that of virgin UHMWPE in fresh serum lubricant at 30 MPa loading, while there were little differences in either ultrapure water or PF serum or DPF serum. And vitamin E-containing UHMWPE tends to exhibit a lower dynamic friction force within the first few hundred cycles in the case of all serum lubricants at 30 MPa loading. These results suggest that some interaction between the UHMWPE surface and the native conformation proteins was specifically affected by the addition of vitamin E and that some weeping of vitamin E might occur at early stage of sliding. Our results also suggest the importance of the conformational changes of serum proteins for the wear testing.
A STUDY OF CEMENTLESS STEM STABILITY AFTER HIP ARTHROPLASTY IN HEMODIALYSIS PATIENTS
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In recent years, the progressive technology of hemodialysis provides long-term survival for renal failure patients. On the other hand, avascular necrosis of the femoral head from the use of steroids or renal osteodystrophy or femoral neck fracture due to amyloid arthropathy have increased. In such cases, bipolar femoral head prosthesis (FHP) and total hip replacement (THR) are usually performed. But it is at risk of developing severe complications, such as early loosening or infection of the implant. The aim of this study is to evaluate the stability of the cementless stems in radiograms and clinical results after FHP or THR using three types cementless prosthesis in hemodialysis patients.

The study included 14 patients (19 hips) on hemodialysis who underwent FHP or THR using three types cementless prosthesis at our institution between 1983 to 2005 and we could follow up at least two years. There were 8 women (11 hips) and 6 men (8 hips) with an average age of 43.9 years (range, 20-88). The average follow-up was 6.75 years. The average hemodialysis term was 10.5 years. Three types of hip prosthesis (7 stems were CLS, 6 stems were IMC, 6 stems were Duetto S-I) has been used for the treatment at our institution in the past. The initial diagnosis was avascular necrosis of the femoral head in 8 hips, femoral neck fracture in 5, osteoarthritis in 4 and amyloid arthropathy in two. We assessed at least 3° of varus-valgus deviation or at least 3 mm of subsidence as aseptic loosening of stems, and assessed radiolucent line and stress shielding of the stems in radiograms, also. As for clinical results, we measured postoperative infection rate and revision rate.

Aseptic loosening of stems were identified in 3 hips (15.8%). Radiolucent lines were identified in 5%-26% of hips categorised by Gruen’s classification zonel-VII, although their zones differed according to the stem model. Stress shieldings were identified in 10 hips (53%), most of which were level 1, according to the criteria described by Engh et al. Infection rate and revision rate were 5.3% (1 hip) and it was a long-term hemodialysis patient.

Several studies report, there is a high probability that early loosening of the stems is associated with amyloid deposition. We experienced early loosening of the stems in our case and considered prevention of amyloid deposition very important in improving the prognosis of the arthroplasty. We must follow carefully hemodialysis patients after an operation because their nutrition level is low and their bodies are compromised due to steroids use and their postoperative infection rate is high.
Introduction: Much debate exists regarding sparing or sacrificing the posterior cruciate ligament (PCL). The posterior cruciate ligament is said to maintain proprioception and stabilization post knee arthroplasty. Substitution of the PCL can require more femoral bone resection, but is thought to improve range of motion. Release of the PCL can restore extension and enhance flexion through greater femoral rollback. Bicruciate implants potentially offer greater flexion and enhanced stability. Each implant design with mechanical instruments requires a different surgical technique making it difficult to directly compare the patient and surgical outcomes. Computer navigation eliminates the differences in implantation between the various implant designs and theoretically allows a more direct comparison of implants based on design characteristics and not surgical technique. The purpose of this paper is to review four different implant designs implanted by a single surgeon with a computer assisted, gap balancing technique to determine if there was any difference in patient outcome.

Methods: A total of 504 implants consisting of posterior cruciate sparing (PFC-RP), PCL substituting (PFC-RPC), PCL sacrificing (LCS) and bicruciate (Journey) implants performed by a single surgeon were reviewed. The PFC-RP group (260) was the largest, followed by the LCS (124), the PFC-RPF (80) and the Journey Knee (40). Outcomes reviewed were range of motion, function, pain and radiographic data to include alignment and evidence of radiolucency.

Results: Demographic data of groups compared included 175 men and 329 women. Mean ages ranged from 61 to 74 years. Preoperative scores among all groups were similar with the cruciate substituting group slightly lower in function, flexion and with more pain before surgery. Overall function improved across all groups through two years, with better scores in the Journey and LCS implants (77 and 73 points) versus RPF (47) and PFC retaining group at (68) at one year (A perfect score is 100). Flexion values were comparable between all groups at one and two year intervals with Journey the highest mean flexion (116 degrees) at one year and with the PFC-RP offering the highest mean flexion at the two year mark (115 degrees). The RPF group at the one year mark had more pain overall (28) versus the other three groups (Journey 45, LCS 42, Sigma RP 45). No patients in any group were revised for instability. Other surgical complications were equal in each group.

Discussion: While the PCL substituting knee patients (PFC-RPF) had lower pain, function and flexion at 12 months compared to all other groups, they started with lower overall knee scores. After accounting for the differences in patients preoperatively, no difference could be found between implant designs when implanted with a similar surgical technique employing a computer assisted gap balancing protocol.

References
HIP ARTHROPLASTY WITH A METAL-POLYURETHANE BEARING IS EFFECTIVE IN FEMORAL NECK FRACTURE PATIENTS
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Although the number of displaced femoral neck fractures treated with hip arthroplasty is steadily growing, the outcomes are not as good as for other surgical indications. As a result, there is no consensus on the ideal type of arthroplasty for these patients. Unipolar and bipolar arthroplasty have a low dislocation rate but implant longevity and functional results are suboptimal. Total hip arthroplasty (THA) provides better functional outcomes and implant longevity but it is associated with a high incidence of postoperative dislocation. This constitutes a significant limiting factor for a more widespread use of this procedure.

The TriboFit® Buffer (Active Implants Corporation, Memphis, Tennessee, USA) is a 2.7 mm-thick cup made of polycarbonate-urethane which mimics the mechanical characteristics of human cartilage. It is a pliable, hydrophilic, biocompatible, endotoxin-resistant material and acts as a stress-absorber, transmitting loads to the subchondral bone in a physiological manner. The TriboFit® Buffer shows excellent tribology, including ideal fluid film lubrication, low friction, high load carrying capabilities and long endurance.

The TriboFit® Buffer is fixed using flexible mechanical fixation. With a special instrument, a circumferential groove is cut into the patients’ socket. The TriboFit® Buffer is seated by applying gentle pressure, with its ledge snapping tightly into the groove. The surgical technique is bone sparing as no acetabular bone reaming is required whatsoever. The TriboFit® Buffer can be coupled with large diameter cobalt-chromium femoral prosthetic heads of the same dimensions as the patients’ femoral head. By restoring the correct hip anatomy and preserving the original size of the femoral head, hip range of motion (ROM) and stability are optimised.

Within a multi-centre study, 224 patients (63 male and 161 female) with femoral neck fractures were treated with the TriboFit® Buffer, a large diameter head and either cemented (192) or uncemented femoral stems (32). The mean patient age was 83 years (range 65 to 96). All surgeries were performed using a standard anterolateral approach.

Rehabilitation was fast and weight-bearing was as tolerated by the patients. There were no major complications, and in particular, no postoperative dislocations were reported.

At a mean follow-up of one year, X-rays showed good implant stability. The mean Harris hip score (HHS) after one month was 58 points and increased to 80 points at one year (p = < 0.05). The ROM was the same as in the intact hip. Only one patient was revised because of nonimplant-related pain. This patient complained of pain in the surgically treated limb which was in actual fact related to spinal stenosis. Analysis of the retrieved implant revealed a loss of thickness in the superior area as well as minimal weight (approximately 2.4%). The backside revealed evidence of macroscopic wear in the area of directional loading from the femoral head to the acetabulum. The bearing surface showed minimal wear (less than 15 mm3), indicating that the primary wear location was on the backside. Retrieved synovial fluid and tissue analysis confirmed that there was no reactivity and no sign of synovitis.

With femoral neck fracture patients, TriboFit® Buffer arthroplasty is theoretically superior to both hemiarthroplasty and THA as it should involve the same low risk of dislocation and acetabular bone preservation associated with hemiarthroplasty, together with the same good functional results and consistent implant longevity of THA. Other advantages of this technique include reduced bleeding and short surgical times.

The results of this study show that the new TriboFit® Buffer arthroplasty technology has the potential to revolutionize the surgical treatment of displaced femoral neck fracture.
FUNCTIONAL OUTCOMES FROM HIGH FLEXION CR VS PS TOTAL KNEES
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This research is to relate functional outcomes to kinematics in high flexion CR and PS total
knees by using the Total Knee Function Questionnaire in patients who had previously undergone
kinematic analyses.

Patients were identified who had primary total knee arthroplasty and had undergone
kinematic analyses using fluoroscopy. The Total Knee Function Questionnaire was sent to these
patients, and data was obtained for 14 CR knees (NexGen CR-Flex, Zimmer) and for 13 PS
knees (Legacy LPS-Flex, Zimmer). The questionnaire evaluates baseline activities of daily
living, advanced activities, and recreational activities and exercises.

CR patients reported higher satisfaction and that their knees felt more “normal” than PS
patients. Some baseline activity scores were significantly higher for CR than for PS knees.
Limitations in baseline activities were related to kinematic constraints, including flexion, lateral
and medial anterior-posterior (A-P) translations, and tibiofemoral axial rotation. Kinematic data
were related to difficulty data for advanced and recreational activities of kneeling, squatting,
gardening, and stretching.

Comparisons between kinematic data and patient feedback on knee function provided
unique information about differences between CR and PS high flexion implants. CR patients
had better function than PS patients in walking on even ground or uphill or sitting. CR patients
had higher activity scores for recreational than for advanced activities, while activity scores for
the PS patients were similar between these activities. Kinematic variables that affected function
for some activities included extremes of flexion, A-P translations of lateral and medial condyles,
and axial rotation intervals.
A SINGLE TOTAL KNEE ARTHROPLASTY SYSTEM WITH BROAD SIZE AND CONSTRAINT OPTIONS IMPROVES OUTCOMES FOR BOTH MEN AND WOMEN
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Surgeons theorize smaller increments in sizing might better address different sized femurs and size differences between genders. This study examines utilisation of intermediate sized components to determine if availability affects outcomes of women and men undergoing total knee arthroplasty (TKA).

We reviewed 1903 consecutive, primary TKA in 1519 patients (64% women) performed with a single implant system. Originally, six femoral sizes were available; four intermediate sizes were added later. The system allows interchangeability of all femoral and tibial sizes and has seven constraint options. Four hundred and five TKA were done prior to intermediate size availability. In women before, 49% were 65mm, 47% 60mm, and 3% 70mm. After, 32% were 62.5mm, 21% 65mm and 8% 67.5mm. In men, 70mm was the most common representing 49% before and 41% after. The 65mm in men dropped from 29% before to 16% after and the 75mm dropped from 21% to 14%. After, 23% were 67.5mm. Minimum follow-up was two years. When comparing women before versus after, women after had significantly better postoperative Knee Society (KS) pain (p=0.0000), clinical (p=0.003) and function scores (p=0.0000), and improvement in clinical (p=0.0000) and function scores (p=0.0001) while improvement in pain score was similar. Men done after had better postoperative KS pain (p=0.02) and function scores (p=0.002), and improvement in KS clinical (p=0.001) and function (p=0.0002) scores.

Both men and women undergoing TKA after availability of half sizes had better postoperative KS pain, clinical and functional scores, and improvement from preoperative levels compared with men and women before. We conclude a single TKA system with a wide variety of sizing and constraint options can provide consistently excellent results for both men and women undergoing TKA.
Hip resurfacing arthroplasty is a technically challenging procedure, and orientation of the femoral component is critical to avoid implant failure. Recently, numerous articles have shown that the use of computer-assisted navigation decreases the learning curve for beginners in hip resurfacing and to improve the surgeon’s ability to produce consistent results. The purpose of this study was to evaluate the learning curve of computer-assisted navigation in the hands of an experienced hip resurfacing surgeon.

This retrospective study was compromised of 100 metal-on-metal total hip resurfacings in 94 patients. The resurfacings were performed by a single fellowship-trained surgeon, with hip resurfacing experience of more than 250 hip resurfacings without navigation. Data collected included gender, age at the time of surgery, BMI, operative time, postoperative complications, and digital planning. Standard interoposterior (AP) radiographs taken in the preoperative and postoperative period were evaluated to measure neck-shaft and stem-shaft angles, respectively. There were 24 females and 70 males, who had a mean age of 49 years (range, 19 to 68 years). The 100 hips were arranged chronologically by operative date and broken down into four groups of 25. Data also was gathered on 25 non-navigated hip resurfacings to serve as a matching group.

There were no significant differences found between the four groups and matching groups with respect to patient variables, including age, BMI, or gender. There were also no significant differences found among the groups with respect to OR time (p = 0.565). The mean OR time for all 100 navigated hips was 101 minutes, compared to a mean of 104 minutes for the matching group (p = 0.924). Using linear regression analysis, the only variable that was found to influence OR time was BMI (p < 0.001). The mean actual stem-shaft angle (SSA) of the groups became more valgus over time, with group 1 having an SSA of 139; group 2, an SSA of 140; group 3, an SSA of 142; and group 4, an SSA of 144. Compared to the preoperative neck-shaft angle, the postoperative stem-shaft angle for 89% of the femoral components was inserted in a valgus position, with 96% of those in group 4 being inserted in a valgus position. The matching non-navigated group had only 80% of the cases with the stem-shaft angle inserted in valgus.

The data presented here demonstrates that providing an imageless computer-assisted navigation system to an experienced hip resurfacing surgeon offered the benefits of navigated surgery including increased accuracy, with no learning curve effect. Computer-assisted navigation can help the learning curve of a technically demanding procedure in inexperienced surgeons, as described by the literature, while placing real-time feedback and consistent repeatability into the hands of an experienced surgeon.
THE CUTANEOUS ANTERIOR PELVIC PLANE MAY LEAD TO INACCURACY IN COMPUTER ASSISTED TOTAL HIP ARTHROPLASTY: IN VIVO DEMONSTRATION AND CADAVER VALIDATION OF AN ULTRASOUND METHOD

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Most of computer-assisted computer assisted system rely on the peri-operative acquisition of the anterior pelvic plane defined as the plane crossing the two anterior iliac spine and the symphysis. The goal of this study was to evaluate in vivo and in vitro the accuracy of the anterior pelvic plane acquisition, considered as the reference for computer-assisted total hip arthroplasty (THA).

Cup placement was performed using an imageless computer-assisted system in thirty patients during THA. Post-operatively the position of the cup was evaluated on computed tomography using a validated tridimensional software. The differences between the perioperative and postoperative angles for abduction and anteversion were compared using a two-group pair test.

On two cadavers four clinicians performed ten times the anterior pelvic plane acquisition using three methods: percutaneously, with ultrasound and by direct bony acquisition defined as the reference. The mean error for each anterior pelvic plane acquisition method was compared using a univariate variance model for repeated measurements. In vivo, the mean difference between the perioperative and postoperative abduction angles was 4º and not statistically significant. For anteversion, the difference was 11º and significant in patients with BMI > 27 (p<0.001). In vitro, the mean errors for rotation and tilt were respectively 3.8 º and 19.25 º for cutaneous acquisition, 2.8º and 6.2º for ultrasound acquisition method. The errors were statistically higher with the percutaneous method (p< 0.001).

According to our results, the accuracy of the standard percutaneous acquisition method of the anterior pelvic plane in computer-assisted THA is limited. The ultrasound acquisition method may represent a reliable alternative.
CASE REPORT- EARLY FAILURE AFTER TOTAL KNEE ARTHROPLASTY WITH USE OF MINIMAL INCISION SURGERY

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Recently, many researches of minimal incision surgery (MIS) total knee arthroplasty (TKA) have been reported, however very few of these contain clinical results. Regardless of this, MIS TKA is widely promoted as an improvement over traditional TKA. Although traditional TKA allows for excellent visualization, component orientation, fixation, and has been associated with remarkable long-term implant survival, many patients expect an extremely small incision, minimal or no pain and discomfort associated with their surgery, and certainly no increase in the complication rate. While there is some evidence that short term benefits may occur, there is concern that there may be an increase in complications with the use of MIS technique. We report here cases that malalignments in early phase were occurred after MIS TKAs. A consecutive series of MIS TKA for varus osteoarthritis undertaken by 2 surgeons at 2 centers during 2-year period (2006-2007) was reviewed. During this interval, 50 MIS TKAs were performed. The mean age was 75.6 years (range 54 to 88 years). Cases for post-operatively infection were excluded. There were 2 cases that early failures due to varus sinking of tibial component were confirmed in early phase (7 and 3 months after primary surgery). We analyzed data between early failed cases and non-failed cases. Patients with early failure were younger, which showed a trend toward significance (p=0.11; failed; 66.5, non-failed; 75.9 years). There was no difference in amount of both medial and lateral side of distal femoral cut between early failed cases and non-failed cases. Proximal tibial cut was significantly larger in early failed cases compared with non-failed cases (p=0.01; failed; 16.5±4.5, nonfailed; 11.4±6.6). There was no difference in Femorotibial angle (FTA) after surgery between them. Substantial backgrounds of occurring early failure after MIS TKA are not still clarified, however, very early failure were occurred in patients, who had significant large cut of proximal tibia, in our experienced cases. MIS TKA may lead to varus imbalance due to increased amount of bony cut and decreased medial soft tissue release. Henceforth, the high prevalence of MIS failures occurring in early phase is disturbing, because of limited working space and warrants further investigation.
STRESS DISTRIBUTION IN THE KNEE JOINT FOLLOWING A HIGH TIBIAL OSTEOTOMY


14.1% of men & 22.8% of women over 45 years show symptoms of osteoarthritis OA of the knee [1]. Knee OA is usually associated with lower limb malalignment [2]; 50 of varus results in 70% - 90% increase in compressive loading of the medial tibio-femoral compartment [3] and OA worsening over 18 months [4]. High Tibial Osteotomy (HTO) enables preservation of bone stock and soft tissue structures and could be an attractive option to younger patients who wish to return to high level activity. However, results of HTOs are unpredictable, which could be due to patient selection or surgical techniques. The long-term aim of this work is to develop a predictive tool to aid the surgeon in the selection of optimal HTO geometry for improved and more consistent surgical outcomes. The first step in achieving our longterm goal was to determine whether stress predictions at the tibio-femoral articulation were sensitive to simulated high tibial osteotomy, using finite element (FE) method.

CT and MRI data of a cadaveric knee were used to create geometrically accurate 3D models of the femur, tibia, fibula, menisci and cartilage and tendon of the knee joint, using the Mimics V12.11 commercially-available software (Materialise, Belgium). The Simulation module was used to register the bones and the soft tissues. The resulting STL files were exported to CATIA V5R18 pre-processor to generate surface meshes and create the corresponding 3D solid and FE models of the osseous and soft tissues from the STL cloud of points.

The Young’s moduli for cortical bone, cancellous bone, cartilages, menisci and ligaments were taken from literature as 17 GPa, 500 MPa, 12 MPa, 60 Mpa and 1.72 MPa respectively [5,6,7]. The Poisson’s ratios for osseous and soft tissues were taken as 0.3 and 0.45, respectively [8]. The nodes between the bones and the corresponding cartilages were merged and surface contact was applied between the cartilages. The distal ends of the tibia and fibula were fixed and a load of 2.1 KN, corresponding to 3 x body weight, was applied perpendicularly to the proximal end of the femur. Results of finite element analyses show a reduction of 67% in principal stresses in the knee joint following an open wedge HTO surgery simulating 100 varus correction. FE analysis results of this study show that HTO reduces stresses in specific regions of the knee, which are associated with OA progression [4]. Our future works include corroborating our results with controlled cadaveric experiments and implementing optimization techniques to predict optimum HTO geometries for patient-specific FE models.

References
Fixed flexion deformity is common in neglected cases of advanced arthritis of the knee. The need and means of complete correction of fixed flexion deformity remains controversial. We analysed 60 patients of advanced arthritis with severe flexion deformity >300 who underwent total knee arthroplasty between January 2002 to January 2008. The age ranged from 54 to 78 years (mean age of 62 years). All surgeries were performed using posterior cruciate substituting implant. Patients were followed for an average period of 42 months.

All patients were operated in a single stage. Distal femoral over-resection was done in addition to posterior, postero-medial and postero-lateral release. Posterior release was done upto the linea aspera. In 2 cases posterior capsular was released directly. A criteria was developed for sequential release on the basis of degree of flexion deformity. Flexion deformity was fully corrected in 48 cases whereas as 50 of residual flexion remained in 5 cases with preoperative deformity of 40-600 and 100 residual flexion remained in 6 cases with preoperative deformity >600. One patient with pre op fixed flexion deformity of 90° had to be treated with arthrodesis.

Our experience suggest that predetermined routine femoral over-resection in moderate to severe flexion deformity prior to balancing knee is not fraught with complications if our criteria are followed. Additional bony cuts (over-resection) and posterior soft tissue release is complementary to each other in correction of flexion deformity and it should be a sequential release. This technique saves time, reduces intraoperative difficulties and helps to correct flexion deformity maximally.
Total knee arthroplasty becomes more challenging when knee arthritis is associated with an extra-articular deformity of the femur or tibia. We evaluated the outcome of navigated total knee arthroplasty in a large series of arthritic knees with extra-articular deformity. We retrospectively reviewed the records of 950 patients who had undergone navigated TKA between January 2005 and February 2008. There were 40 extra-articular deformities in 34 patients, with bilateral involvement in 6 patients which were included in the study. Twenty-two limbs had deformity in the femur and the tibia had deformity in 18 limbs. There were 24 females and 10 males with a mean age of 63.1 years (range, 46-80 years).

The etiologies included malunited fractures (13 patients), stress fractures (4 patients), post high tibial osteotomy (3 patients), and excessive coronal bowing (14 patients). The mean femoral extra-articular deformity in the coronal plane was 9.3° varus (range, 24° varus to 2.8° varus) and the mean tibial extra-articular deformity in the coronal plane was 6.3° varus (range, 20° varus to 8.5° valgus). Three limbs underwent simultaneous corrective osteotomy and the rest were treated with intra-articular correction during computer-assisted total knee arthroplasty. The limb alignment changed from a mean of 166.7° preoperatively to 179.1° postoperatively. At a mean follow-up of 26.4 months, the Knee Society knee score improved from a mean pre-operative score of 49.7 points to 90.4 points postoperatively; function score improved from 47.3 points to 84.9 points.

The results of our study indicate that computer-assisted total knee arthroplasty is a useful alternative to conventional total knee arthroplasty for knee arthritis with extra-articular deformity where accurate restoration of limb alignment may be challenging due to the presence of a deformed tibia or femur or in the presence of hardware.
KNEE KINEMATICS IN PATIENTS WITH BILATERAL TKA OF TWO DESIGNS DURING MAXIMUM FLEXION ACTIVITIES

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Total knee arthroplasty (TKA) increasingly is utilized to treat younger, more physically active, or more culturally diverse patients who desire the ability to perform activities with high knee flexion. As a result, many implant manufacturers have modified designs or introduced new ones to better facilitate deep knee flexion. To date, a mix of studies has reported superior or equivalent flexion performance comparing high-flexion and traditional implant designs. Importantly, many of these studies are conducted with the patient supine in non-weightbearing postures, not in functional postures where differences in joint mechanics are better manifest. The goal of this study was to evaluate weightbearing kneeling and lunging knee kinematics in patients with bilateral TKA of two types.

Nine high functioning patients from the American Southwest provided informed consent to participate in this single-surgeon study. The subjects averaged 74 years of age and included three females. Each subject received a traditional cruciate-retaining TKA in one knee and a flexion-enhanced cruciate-retaining (7 knees) or posterior-stabilized (2 knees) TKA in the other. The traditional knees were an average of 84 months postoperative and had combined Knee Society Scores averaging 183. The knees with new TKA designs were an average of 31 months postoperative and had combined Knee Society scores averaging 188. Subjects were observed performing a weight-bearing lunge to maximum comfortable flexion and partially weightbearing kneeling to maximum comfortable flexion using lateral fluoroscopy. Model-image registration techniques were used to quantify the 3D translations and rotations of the tibial and femoral components.

There were no differences in maximum knee flexion during lunging (115°±12° versus 118°±7°) or kneeling (120°±14° versus 120°±10°) for the traditional and flexion-enhanced TKA’s. Tibial internal rotation and abduction were not different. The locations of the medial and lateral condyles were significantly more posterior in the traditional design for both activities (p<0.05).

This study examined maximum flexion knee kinematics in clinically excellent, high performing subjects with bilateral TKA of two types. No clinically important functional differences were observed. Although flexion-enhanced designs may provide improved flexion for patients who demand it, older patients living a Western lifestyle appear to do equally well with the traditional and flexion-enhanced TKA designs.
BIOTRIBOLOGICAL AND STRUCTURAL CHARACTERISATIONS OF 28MM DIAMETER ZTA-ZTA HIP JOINTS UNDER STANDARD AND AGGRESSIVE WEAR CONDITIONS USING PROSIM HIP SIMULATOR
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Artificial hip joints have been in use for a number of years; various combinations of metals and polymers have been tested both in vitro and in vivo. Modern ceramics have found application as bearings in hip replacement due to the enhanced wear and friction that they offer. It has been hypothesised that during the swing phase of gait it is possible for the Femoral head and the Acetabular cup to dislocate, before relocating during heel contact. Severe loading such as this could cause greater levels of wear to occur in artificial hip joints. This study provides comparative analysis between ceramic-on-ceramic hip joint pairings under both severe and standard loading profiles.

Five zirconia-toughened alumina (ZTA) 28mm diameter bearing pairs were tested on a ProSim Hip Simulator for 5.3 million cycles (MC), two under severe loading and three under standard loading conditions. Additionally a Loaded Soak Control, Soak Control and Environmental Control were used. Wear was recorded every 0.5 MC by gravimetric measurement. Surface microscopy images from a Zygo New View 100 and an Atomic Force Microscope (AFM) were taken before testing and then at, 0.5 MC, 2.5 MC, and 5.3 MC.

The standard loading profile followed ISO14242-1 standard with 2650±50N maximum force, ±10º internal-external rotation and -15–30º flexion-extension. To simulate aggressive wear condition, microseparation inferiorly and micro-lateralisation laterally were applied during the swing phase. Dual acting cylinders were used to apply a constant force of 350±50N in opposition to the standard loading profile to enable separation between the Femoral Head and the Acetabular Cup during the swing phase. This microseparation was measured by means of a Linear Variable Differential Transformer (LVDT) and the setting gave a reading of 1.2mm ± 0.1mm at the start of each 0.5 million run. The value for microlateralisation was 0.9mm whilst the inferior separation was 1.2mm.

Wear rates for the ceramic cups under severe wear condition were found to be 0.0356±0.0059mm³/MC and for the standard wear condition to be 0.0178±0.0049mm³/MC. The femoral heads had wear rates of 0.0164±0.0046mm³/MC for severe wear condition and no wear was detected for the standard wear condition.

The results of the present study showed almost no wear under standard gait condition and only a modest increase in wear occurred when using severe wear condition. Thus the resulting wear rates are still significantly lower than those found for alumina-alumina total hip joints [1, 2].

REFERENCES
IN VIVO ASSESSMENT OF HIP KINEMATICS IN THA PATIENTS WITH VARIOUS BEARING SURFACES: A MULTI-CENTER STUDY
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In vivo kinematic analyses of total hip arthroplasty (THA) have determined femoral head separation from the medial aspect of the acetabular component can occur. Various bearing materials are currently used in THA today. The objective of this study was to determine if differences in the incidence and magnitude of femoral head separation exist among various bearing surfaces for THA during different weight-bearing activities.

205 clinically successful subjects implanted with either metal-on-metal (MOM), metal-on-polyethylene (MOP), ceramic-on-ceramic (COC) or ceramic-on-polyethylene (COP) materials were analyzed using video-fluoroscopy. Each patient performed either gait on a treadmill or an abduction-adduction activity. The fluoroscopic information was then analyzed using a computer aided 3D model fitting technique to determine the incidence and magnitude of hip separation. Additional variables analyzed included femoral head diameter, follow-up duration, and type of surgical approach utilized.

Less separation was noted with increasing femoral head diameter during abduction-adduction. Increased separation was observed during gait as follow-up duration increased. Hip separation was greater during gait when a posterolateral surgical approach was used but was greater in abduction-adduction if an anterolateral approach was selected. The incidence and magnitude of hip separation during gait was least in subjects with COC THA and least with COC and MOM THA when analyzed during abduction-adduction.

It's been proposed that THA patients are subject to femoral head separation due to alterations in the soft tissue supporting structures during THA that affect constraint of the joint. The current analysis demonstrates lower magnitudes and incidence of THA separation occur when hard-on-hard bearing surfaces are selected and can vary based on femoral head diameter, follow-up duration, and surgical approach used. Potential detrimental effects resulting from THA separation include premature polyethylene wear, component loosening (secondary to impulse loading conditions) and hip instability.
Total hip arthroplasty (THA) and Total knee arthroplasty (TKA) are successful operations that predictably restore function and provide pain relief for up to 20 years. What happens if they fail in the elderly patient? The purpose of this review was to evaluate pain relief, function and quality of life (QOL) in octogenarian patients undergoing revision total joint arthroplasty (TJA).

We reviewed our surgical database to find all patients who were 80 years or older at the time of revision surgery. From 1993 through 2008, there were 61 revision THAs (52 patients) and 33 revision TKAs (29 patients). This represented 3% and 8% respectively of all arthroplasties and revision arthroplasties done during the same period. Outcomes evaluated include Harris Hip Scores (HHS), Knee Society Scores (KSS), complications, and QOL.

The average follow-up for revision THA patients with completed Harris Hip Evaluations was 27 months (range: 3 – 126 months). HHS improved from 47 preoperatively to 74 at most recent follow-up. Pain Scores improved from 20 to 39, Function Scores from 11 to 16, Activities Scores from 9 to 10, Deformity Scores from 2 to 4 and ROM Scores from 5 to 6. Complications occurred in 34% of these cases. The average follow-up for revision TKA patients with completed Knee Society Evaluations was 38 months (range: 11 – 98 months). KSS improved from 48 preoperatively to 84 at the most recent follow-up. Pain Scores improved from 22 to 43 and Function Scores from 20 to 34. Complications occurred in 47% of these cases.

Total HHS and KSS greatly improved postoperatively with the most notable improvement in the Pain category. Complications were common, although most were considered minor. More severe complications occurred when revisions of all components were needed, more likely in TKA than THA. With careful selection, patient education and preoperative planning, revision TJA can be done safely and provide benefit for the elderly patient.
Purpose: Cement implantation syndrome characterized by hypotension, hypoxemia, cardiac arrhythmia or arrest has been reported in the literature. Pulmonary embolization is thought to be the main reason. In our institute, however, we have not experienced major hypotension during THA. To improve longevity of THA, interface bioactive bone cement technique combined with modern cementing technique has been used in our institute. Main principle of this technique is smearing hydroxyapatite granules on the dry bony surface followed by cement pressurization. The purpose of the present study was to monitor blood pressure soon after cementing. "Method" The present study includes 91 cases of primary THA with an average age at operation of 64 years old (ranging 35 to 85). Under general anesthesia, both components were cemented using antero-lateral approach. Systolic arterial blood pressure was monitored until 5 minutes with 1 minute interval. The maximum regulation (MR%) was calculated as (maximum change blood pressure – blood pressure before cement insertion) divided by blood pressure before cement insertion. "Results" No major complications such as cardiac arrest were observed. In most of the cases, blood pressure increased until 4 minutes for the acetabular side and 2 minutes for the femoral side, and then returned to the blood pressure before cement insertion gradually. In the acetabular side, MR% was 10±13 (-19-40%). In 52 joints (57.1%), MR% was between 10 to 40 %. In the femoral side, MR% was 5±12 (-20 to 31%). In 32 joints (35.2%), MR% was between 10 to 31 %.

Conclusion: In the present study, major hypotension was not observed. Blood pressure increases if left ventricle reacts to the pulmonary hypertension caused by micro-embolization. If major pulmonary embolization occurs, blood pressure decrease because left ventricle can not compensate for major pulmonary hypertension caused by mayor pulmonary embolization. By good cementing technique which includes washing out debris or fat and obtaining dry bony surface just before cementing, blood pressure soon after cementing was increased.
PRECLINICAL EVALUATION OF A PYROCARBON CERVICAL TOTAL DISC REPLACEMENT
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An unconstrained, articulating pyrocarbon cervical total disc replacement (TDR; Rescue, Biomet, US) has been developed. Pyrocarbon is a chemically inert form of carbon with an elastic modulus similar to bone. The long-term durability and wear resistance of pyrocarbon has been demonstrated in other orthopaedic devices. The purpose of this study was two-fold: to compare the wear of identical disc replacements fabricated from cobalt chrome (CoCr) and ultrahigh-molecular-weight-polyethylene (UHMWPE) to pyrocarbon and to compare the motion at index and motion segments before and after Rescue TDR.

Ten pyrocarbon and three CoCr-UHMWPE TDRs were subjected to 10 million cycles in 20 degrees of flexion–extension with 155N axial load in serum solution at 4.0Hz. One additional CoCr-UHMWPE couple was immersed in serum and loaded to 155 N. TDRs and serum solution were examined at 0, 2.5, 5, 7.5 and 10 million cycles to characterize wear. The surfaces were measured with a coordinate measuring machine prior to and after 10 million cycles. Serum solutions and time controlled serum-only controls were characterized for the quantity of wear debris using particle analysis. Nine cadaver cervical spines were placed through dynamic 2Nm cycles of flexion, extension, and lateral bending. Electromagnetic sensors recorded the motion of each vertebral body in response to applied loads. Total range of motion at the index and adjacent levels were determined for the intact spine and after TDR.

There was no significant difference in the pyrocarbon surface geometry after 10 million cycles or in the number of particles generated during testing compared to baseline (p >0.05). However, CoCr-UHMWPE devices displayed classic patterns of total joint wear. CoCr-UHMWPE wear couples had an initial increase in serum particles, followed by lower particle producing rates that gradually increased. The difference in mean UHMWPE wear particles at each interval was significantly greater than with the pyrocarbon TDR (all p<0.05).

The mean total and dynamic ranges of flexion-extension and lateral bending after implantation of the Rescue TDR at the index level were not statistically significantly different from that of the intact spine (ANOVA: p > 0.05). Similarly, at the superior and inferior adjacent levels, the mean total and dynamic range of flexion-extension and lateral bending after implantation of the Rescue device were not statistically significantly different from the intact spine (ANOVA: p > 0.05).
PREDICTING BACTERIAL POPULATIONS BASED ON AIRBORNE PARTICULATES DURING TOTAL JOINT ARTHROPLASTY
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Prevention of surgical infection following joint arthroplasty is preferable to treatment. Prevention requires identification and control of the potential sources of microbial contamination. The purpose of this study was to determine whether the density of airborne particulate in the operating room during total joint arthroplasty could predict the density of viable airborne bacteria at the surgery site.

A standard particle analyzer was used to measure the number and diameters of airborne particulate during 22 joint arthroplasty surgeries performed in non-laminar flow rooms. An impact air sampler and standard culture plates were used to collect airborne particulate and were analysed to identify and count colony-forming units.

Particulate density averaged >500,000 particles/ft³, and 1,786 colony-forming units were identified, primarily gram-positive cocci. The density of particles ≥10μm explained 41% of the variation in colony-forming unit density. Colony-forming units and ≥10 μm particle density increased with longer surgery duration and higher staff counts.

This is the first study to the authors knowledge that shows a correlation between the number of persons in the OR and CFUs at the surgical site during total joint arthroplasty procedures. Increasing surgical staff appear to produce both more particulate and more CFUs. These observations support the use of environmental controls that isolate and protect the surgical site from airborne particulate and microbial contamination. Continuous monitoring of particulate larger than 10 um during joint arthroplasty procedures may be warranted.
NORMAL, FUSED AND DEGENERATIVE CONDITIONS OF THE LUMBAR SPINE: A COMPARISON STUDY OF THE 3D IN VIVO MECHANICS
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Low back pain (LBP) in the region of the lumbar spine is a significant problem among individuals, and efforts focused on treating both the symptoms and causes of LBP have proven to be difficult. Aside from conservative treatments, the predominant surgical approach for treating degenerative spine conditions has been to fuse the vertebral bodies at the symptomatic level. Even today, surgical fusion and its effect on adjacent levels are still not fully understood. Therefore, the objective of this study was to use fluoroscopy and mathematical modeling techniques to identify the in vivo kinematics and kinetics in subjects having either a normal, degenerative or fused condition of the lumbar spine.

Twenty-five subjects (ten normal, ten degenerative, and five fusion) were evaluated under fluoroscopic surveillance while performing flexion/extension of the lumbar spine. Subjects within the normal and degenerative groups were analyzed only once, while subjects from the fusion group were analyzed both pre-operatively and at a minimum of six months post-operative. The fusion group consisted of three subjects symptomatic at L4/L5, with the remaining two subjects symptomatic at L5/S1. In vivo kinematics data were derived using a 3D-to-2D model fitting algorithm and served as input into a 3D mathematical model of the lumbar spine. The parametric, inverse dynamics mathematical model was created to allow for the determination of the bearing surface contact and muscle forces at each level of the lumbar spine.

Three-dimensional kinematics analyses revealed that subjects classified as having a normal lumbar spine experienced a more uniform motion pattern compared to those observed in the degenerative and fusion groups. Alternatively, the degenerative and fusion subjects demonstrated a more coupled motion pattern in order to perform in plane flexion/extension. Compared to the normal group, rotations in the sagittal plane decreased by an average of 28% at the pathological level in the degenerative group, while in the fusion group segmental motions slightly increased at the adjacent levels. Results from the mathematical model also revealed higher out-of-plane forces and increased loading at symptomatic and adjacent levels in both the degenerative and fused groups compared to forces observed in the normal spine.

The abnormal motion patterns, which result from decreased or loss of motion at pathological levels in the degenerative and fusion groups, are believed to result in higher resultant forces in the spine. This may be subjecting the intervertebral discs to increased stresses, and as a consequence may be linked to more rapid degeneration at levels where the abnormal kinematics are occurring.
THE EFFECT OF CONDITIONALLY SURFACE DEMINERALIZED BONE CAGE ON SPINAL INTERBODY FUSION
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This study aims to identify the efficiency of biomechanical and bioactive properties of the bovine cortical bone cage treated with conditionally surface demineralization.

The procured bovine femoral bones were got rid of lipid, protein, and blood materials by chemical process such as 3% hydrogen peroxide and 70% ethanol. The long shaft bones were cut by band saw. Several bone cages were processed by milling machine. The cortical bone cages were demineralized by 0.6N HCl treatment with various conditions, which were the tendency of HCl treatment time, position, direction. After neutralization with pH 7.0, phosphate buffered saline washing and freeze drying process, the vial vacuum packed bone cages were sterilized by 25kGy gamma irradiation. The SEM and EDS system were proceeded for morphology and Ca content in various layers of bone cage. In vitro test for cell viability and differentiation, extracted supernatant from each bone cage by tissue culture was treated in MC3T3E1 cells. For indentifying releasing materials, the others were carried for quantitative analysis by ELISA. After each conditioned period, mRNA expression was compared by RT-PCR. The axial compression and bending strength were measured by universal testing machine (UTM) for biomechanical property.

Between the outer layer and inner layer of bone cage for 2 hour’s HCl, there was concentrated Ca extracted layer. The tendency of Ca content and direction of demineralised treatment had effects on the compression and elastic strength. In vitro test, initial Osteogenic transcription factor’s mRNA expression and quantitative result of releasing material had rewarding regulation by HCl-treatment time and treated direction. Conditionally surface demineralized bone cage had good osteoconductivity and osteoinductivity for spinal interbody fusion.
CORRELATION OF 3D IN VIVO PATELLOFEMORAL KINEMATICS WITH SOUND DATA FOR TKA AND NON-IMPLANTED KNEES
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Previously, Komistek et al. have shown that the kinematics of the patellofemoral joint is altered after a TKA surgery. Specifically, the implanted patella experiences significantly less rotation than the natural patella. Also, in early flexion, the patellofemoral contact positions differed significantly between implanted and non-implanted patellae. It was also found that some of TKA subjects experience patellofemoral separation. These kinematical differences may lead to adverse mechanical conditions and increase fatigue or cause loosening of the implant components. This study’s objective was to determine the three-dimensional patellofemoral kinematics and correlate it with the in vivo sound (vibrations) detected using accelerometers for subjects having a TKA and a non-implanted knee under in vivo, weight bearing conditions. The correlation of the knee mechanical conditions with the vibration data may indicate new parameters that may be used to diagnose the condition of the articular cartilage or implant components.

Fifteen subjects (average age 71.8 ±7.4 years) having one implanted knee (mobile bearing Hi-Flex PS) and the healthy contralateral knee, performed (1) deep knee bend to maximum flexion, (2) chair rise and (3) stair climb activities under fluoroscopic surveillance. Three miniature, piezoelectric, three-axial accelerometers were attached to the patella and femoral epicondyle. The study was approved by the Institutional Review Board and informed consent was obtained from all subjects. The sensors detected the vibration magnitudes and frequencies of the articulating patellofemoral joint surfaces. The signals were amplified and low-pass filtered at 5 kHz by a signal conditioner. The 3D tibiofemoral and patellofemoral kinematics were derived for both knees using a previously published 3D-to-2D registration technique. The 3D bone models were recovered from CT scans, while implant models were obtained from the manufacturer. The patellofemoral rotations were described using the Grood and Suntay convention. The kinematics and sound data were synchronized and recorded under fluoroscopic surveillance, for 10 patients. Then a subset of seven subjects having a TKA was re-analyzed for their contralateral (non-implanted) knee. The vibration signal was then converted to audible sound and correlated with the 3D kinematics.

On average, the subjects achieved more flexion with their TKA (103.4°±15.9°) than with their contralateral knee (96.3°±18.3°). The patellofemoral kinematics varied between the TKA and nonimplanted patella groups; the resurfaced patella experienced less flexion, less medial rotation and less tilt than the contralateral patella. The patellar flexion results were consistent with previously reported literature for both TKA and non-implanted patellae. Also, the resurfaced patellae contacted the femur more proximally than healthy patellae. Audible signals were found for both groups of subjects. The frequency analysis demonstrated that specific frequencies were in similar range for both groups, but the magnitudes and variations were different for the TKA and contralateral knees.

This study correlated 3D patellofemoral kinematics with sound under in vivo conditions for three different activities. Variable audible signals were detected for TKA and non-implanted knees. Vibration magnitude and frequency identification, under in vivo conditions, for TKA may lead to a better understanding of wear and failure modes with respect to the patellofemoral mechanics, more specifically, the patellar insert. Currently this initial study is being expanded to degenerated knee joints and failed TKAs for possible applications of the vibration analysis to the early diagnosis of knee arthritis, detection of implant loosening or wear and monitoring of implant osteointegration progress.
A critical objective of cervical total disc replacement (TDR) is to restore predictable reproducible range-of-motion (ROM) with correct kinematics, while maintaining stability of the segment. Current articulating cervical TDR devices feature fixed centers of rotation, sometimes coupled with unconstrained translation in one or more vectors. The difficulty they have in restoring reproducible, kinematically correct motion has manifest as subsequent facet degeneration as well as other problems. A Tri-Lobe articulating cervical TDR has been developed to recreate predictable, kinematically correct motion, as well as to address other common TDR problems including placement sensitivity, excess wear, instability, and imaging compatibility. The Tri-Lobe TDR design features three incongruent, self-centering, hard-on-hard articulations arranged in a tripod configuration - three hemispherical lobes oriented in a tripod configuration on the superior component articulating against mating non-congruent hemispherical pockets on the inferior component. The diameter and spacing of these articulations determines a specific - kinematic - envelope, and has been designed to match the 6-D anatomic motion data from available published sources. It has diamond-on-diamond articulations to sustain the elevated Hertzian stresses of its incongruent bearing geometry, and is engineered to couple motions in a physiologic manner. This study was designed to compare the variability and reproducibility of a Tri-Lobe cervical TDR as compared to the intact spine, and compared to a ball & trough control TDR design.

Seven human cervical spines (C2-C7) were studied (two pilot and five test specimens) utilizing a 7-Axis spinal testing system. A hybrid load/position control protocol was used to test the specimens. The intact spine was tested first in flexion/extension, lateral bending, and axial rotation to 1.5Nm. Then the C4-C5 segment was implanted with the test and control TDRs utilizing an implant placement fixture that provided accurate reproducible placement of the device in the spine. The order of test and control device placement was randomly varied. Data collected included applied moments, forces, and rotations at C2 and C7, and 3D vertebral movements via an optical tracking system (Optotrak). Statistical analysis of kinematic data was performed with paired-ANOVA followed by a Tukey-Kramer HSD post hoc test.

The ROM for flexion/extension (FE), lateral bending (LB), and axial rotation (AR) are as follows: Intact cervical motion segment FE ROM averaged 4.6±1.0 degrees (max 7.5, min 2.6, range 5.0), LB ROM averaged 1.6±0.6 degrees (max 2.5, min 1.3, range 1.2), and AR ROM averaged 9.3±0.8 degrees (max 11.7, min 6.8, range 4.8). For the Tri-Lobe TDR FE ROM averaged 4.7±0.7 degrees (max 6.5, min 2.5, range 4.0), LB ROM averaged 1.9±0.3 degrees (max 2.5, min 1.2, range 1.3), and AR ROM averaged 10.7±0.3 degrees (max 11.9, min 8.4, range 3.5). For the Ball & Trough TDR FE ROM averaged 4.9±1.6 degrees (max 9.3, min 1.5, range 7.8), LB ROM averaged 2.1±0.5 degrees (max 3.1, min 0.7, range 2.4), and AR ROM averaged 11.0±1.3 degrees (max 13.6, min 8.3, range 5.3). While there was not a statistically significant difference between the Average ROM for the intact, Tri-Lobe, or ball & trough design (p=.96), this is misleading. The variance for motion in all three categories for the ball & trough was significantly greater than for both the intact and Tri-Lobe case. Further, for the minima and maxima, the ball and trough had values that were significantly outside the intact values, while, the Tri-Lobe had values close to that of the intact. The ball & trough design
exhibited 1.95, 1.84, and 1.51 times the Range of the ROM compared to the Tri-Lobe in FE, LB, and AR respectively.

Critical surgical objectives in cervical TDR include restoring predictable inematically correct motion to the segment while maintaining stability. Both incorrect and excess motion can lead to instability or facet degeneration. Too little motion fails to relieve adjacent segments of the increased stresses occurring with fusion, and can lead to auto-fusion as well. With conventional articulating cervical TDR, issues such as TDR placement within the disc space as well as variations in normal anatomy can adversely affect reconstructed kinematics. The Tri-lobe cervical TDR studied in this experiment was able to accommodate variations in anatomy and placement providing a highly predictable and reproducible ROM matching very closely the kinematic envelope for the intact spinal motion segment. Its incongruent bearings are the key to its tolerance of variation in anatomy and placement. Its tripod design contributes to its intrinsic stability and self-centering. It may be more forgiving to surgical variability. This is not only desirable in providing the surgeon with flexibility in selecting implantation position to address deformity and bone defects, but also in providing tolerance to unpredictable variations in facet anatomy permitting acceptable motion with stability for a broad range of conditions.
DIAMOND-ON-DIAMOND SIMULATOR STUDIES: THR WITH DISTRACTION AND OTHER NON-CONGRUENT BEARING CONDITIONS

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Statement of Purpose: Hard-on-hard bearing surfaces are finding increasing application in total hip replacements for wear reduction. Polycrystalline Diamond Compacts (PDCs) offer several potential advantages, including ultimate hardness, reduced metal ion release compared to metal-on-metal (MoM) articulations and increased strength/toughness compared to ceramic-on-ceramic (CoC). This study investigates in-vitro wear and friction for a 28mm diamond-on-diamond (DoD) system under normal walking gait and also with distraction.

Methods: Six sets of 28mm PDC femoral heads and 28/41mm PDC acetabular liners (Dimicron, Utah) were tested on a hip simulator (AMTI, Boston). Radial clearances were 18-42 microns. Specimens were mounted anatomically with the cups superior and mounted at 45 degrees. All stations were lubricated with 37°C bovine serum diluted to 17g/l protein concentration. Components were subjected to a 3kN walking cycle (ISO14242-1) for 5 million cycles (MC). This was followed by 2MC of distraction testing with a reduced swing-phase load of 120N, an applied side force of 129N and with the abduction motion disabled. This produced approximately 0.5–0.7mm of horizontal displacement of the center of the head. The lubricant was changed and the components cleaned, dried and weighed at 0.5MC intervals.

Results: All heads and liners gained weight during each portion of the test. Potential mechanisms (still under investigation) include protein adsorption and hydration of metallic phases within the diamond compact. The weight gains were found to be somewhat reversible after drying in vacuum for extended periods (60-90 hours). However, the standard 1 hour drying cycle used for weight measurements during the test was found to be inadequate. Therefore, only the “dry weights” measured after 64-92 hours of vacuum drying at the beginning and end of each test portion were used to compute wear rates.

Overall wear rates for heads and liners for the 5MC of normal gait and the 2MC of distraction testing and for the whole 7MC. 95% confidence intervals are plotted for each set of six heads and liners. Weight changes were converted to volumetric wear using a density of 3,800kgm-3. Even after extended drying, the liners all showed small weight gains. The heads apparently wore slightly during the normal walking cycle but gained weight during the distraction cycle. Overall, the heads showed a small wear rate of 0.17±0.09mm3/MC and the liners showed a small ‘negative’ wear rate of - 0.11±0.07mm3/MC. Due to the uncertainties involved in the drying procedure, it is concluded that DoD wear rates were unmeasurably low for this test. Distraction is known to increase wear rates for CoC systems [1] and might reasonably be expected to have a similar effect for DoD, due to the high elastic modulus of diamond.

However, the 2MC of distraction testing produced only small weight gains. The heads showed no evidence of ‘stripe wear’ as reported for CoC systems.

Conclusions: DoD wear rates were found to be unmeasurably low for an anatomical hip simulator test with and without distraction. Friction factors for DoD were slightly lower than for metal-on-UHMWPE.

THERAPEUTIC MECHANISM AND PRACTICE IN THE TREATMENT OF SCOLIOSIS IN GROWING CHILDREN

Objective: To study on the therapeutic mechanism of an innovated instrumentation--Plate-Rod System for scoliosis (PRSS) and its effectiveness for the surgical management of early on-set scoliosis (EOS).

Method: Between June 2000 and July 2008, 23 patients with progressive EOS who underwent one stage PRSS procedure without bony fusion and had been followed-up for more than 2 years were evaluated prospectively. The mean age at the time of surgery was 7.98 years. The experimental studies including: X-ray analysis; photo-elastic test and type X collagen were studied to express the therapeutic mechanism.

Results: The mean follow up period was 2.8 ±1.4 years, more than 5 years in 5 cases. The mean scoliosis improved from 80.7° to 30.5° after surgery with a corrective rate of 62.2% and in latest follow-up was 34.7°. The length of the growth of the instrumented spine was average 13.3mm. No severe complications in our series. When PRSS is placed in place, compressive stress was found to exert on the convex side, while tensile stress on the concave side of the curvature which were reflected by the changes on the color band in the photo-elastic test and by the changes in width of the disc spaces, and more type X collagen expressed on convex side than concave side, it suggest that compressive stress leads to increase earlier cartilage degeneration of end plate in convex side correlating with the decreased growth of the end plate of this side, and resulting in maximum spinal realignment.

Conclusion: The PRSS which dispenses with spinal fusion and allows extension along with the children's growth, is able to provide and maintain desirable correction of scoliosis in the later growing year due to its modulating efficiency in normalizing the spinal growth. This new device is an effective instrumentation for correcting scoliosis, especially for EOS.

Key words: Plate-rod spinal system PRSS, scoliosis, Surgical correction, spine.
IN VIVO KINEMATICS OF TWO-COMPONENT TOTAL ANKLE ARTHROPLASTY

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We have performed two-component total ankle arthroplasty (TNK ankle) since 1991 and reported good clinical results. However, in vivo kinematics of this implant are not well understood. The purpose of this study was to measure three-dimensional kinematics of total ankle arthroplasty during non-weightbearing and weightbearing activities.

Forty-seven patients with a mean age of 71 years were enrolled. Preoperative diagnosis was osteoarthritis in 36 patients and rheumatoid arthritis in 11 patients, and the mean followup was 50 months. Radiographs were taken during nonweightbearing maximal dorsiflexion and plantarflexion, and weightbearing maximal dorsiflexion and plantarflexion. Three-dimensional kinematics were determined using 3D-2D model registration techniques. Anatomic coordinate systems were embedded in the tibial and talar implant models, and they were projected onto the radiographic image. Three-dimensional positions and orientations of the implants were determined by matching the silhouette of the models with the silhouette of the image.

From non-weightbearing dorsiflexion to plantarflexion, the talar implant showed 18.1, 0.3, and 1.2 degrees of plantarflexion, inversion, and internal rotation respectively. It also translated 0.8mm posteriorly. There was not significant difference between non-weightbearing and weightbearing kinematics except for the plantarflexion angle (p = 0.007). Posterior hinging, in which tibiotalar contact was seen at only the posterior edge of the talar implant, was observed in 16 patients at either non-weightbearing or weightbearing plantarflexion. There was significantly larger plantarflexion in patients with posterior hinging than patients without hinging (p < 0.001). Nine patients showed anterior hinging at maximum dorsiflexion, and 11 patients showed talar lift-off at maximum plantarflexion.

More than half of the patients showed anterior or posterior edge contact, which might cause excessive contact stress and lead to implant failure in the longer term. This phenomenon is due to the difference in rotation axis between the natural ankle and the implant ankle arthroplasty.
COMPARISON OF DIRECT-EXCHANGE VS TWO-STAGE REVISION FOR THE INFECTED THA: A MARKOV EXPECTED-VALUE DECISION ANALYSIS
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Two-stage revisions for the infected THA are associated with lower re-infection rates than direct-exchange (one-stage) revisions, and for this reason are favored in the U.S. However, the two-stage approach may result in increased, but poorly quantified, surgical morbidity. We developed a decision analysis to compare direct-exchange revision to the two-stage approach for treating the infected THA.

We performed a systematic literature search for papers that analyzed direct- and two-stage revisions for the treatment of chronic infections after THA, with a >2 years follow-up. This provided frequencies of the most common postoperative (interim and final) health states. These were converted to monthly probabilities to permit decision analysis. We conducted and previously published two surveys to obtain utility values, one in experienced arthroplasty surgeons and another in patients. Using those probabilities and utilities, we created a Markov cohort modeling the postoperative health states seen during treatment of the infected THA. Sensitivity analysis was performed for each variable in the tree to verify the model's robustness.

Using a 12-month cycle, the Markov model favored direct-exchange revision over the two-stage approach, regardless of whether surgeon- or patient-derived utilities were used (0.941 vs. 0.642 expected value (EV), and 0.889 vs. 0.551 EV, for patient- and surgeon-derived utilities, respectively; p<0.01). These findings were also significant in a lifetime model with a ten-year life expectancy (p<0.01). The findings were robust in sensitivity analyses using a clinically salient range of input variables.

This decision analysis, which used a systematic review of the literature (for complication and outcome frequencies) and published study-specific survey data from patients and experienced surgeons (for utility values of those health states) found direct-exchange arthroplasty to be superior to the two-stage revision for treating the infected THA. This finding was unexpected, in that this is not our typical approach nor is it favored in this country.
We have demonstrated that erythromycin (EM) inhibits wear debris-induced macrophage activation and osteoclastogenesis (both \textit{in vitro} and \textit{in vivo}) through targeting NF-κB signalling. Our clinical trial further verified that oral EM can be efficiently delivered to periprosthetic tissue and improve local inflammation. The purpose of this study was to assess the efficacy of periprosthetic EM delivery in a rat osteolysis model.

The PA coated titanium (Ti) pin (Stryker) was loaded with EM (8 μl = 2.8 mg/pin). Drug release assay showed around 25\% of loaded EM was remained in the PA layer 24 hours after loading. Rats were divided into three groups: (1) saline control (n=5); (2) UHMWPE particle injection (n=7), and (3) UHMWPE particle injection with EM treatment (n=7). Uncoated Ti pins were press-fit inserted into right tibia following the injection 200 μl of either UHMWPE particles (5 mg/ml) or saline (control). The revision surgeries were performed 6 weeks after the first surgery. The previous implanted pins were replaced with new Ti pins either with or without EM coating. Rats were then sacrificed one month after “revision surgery”, and the knee joint samples were collected for μCT and histology analysis.

μCT analysis showed that the value of bone volume (bv/tv) in the group treated with EM (0.26 ± 0.07) was significantly higher than the group untreated (0.14 ± 0.04), while there was no significant difference between EM treated group and the saline control group (0.15 ± 0.11). The parameters of cancellous bone structure all pointed a trend of better structure in EM treated group than other two groups. However, this difference did not reach statistical significance. Histology analysis (H&E staining) demonstrated that in the saline control the tibia retained a smooth endocortical surface with a prominent periprosthetic membrane. In the EM-treated group, endocortical erosion was reduced and the periprosthetic tissue appeared thinner than uncoated pins. The overall cellularity of periprosthetic membranes from the EM-treated group was decreased compared to the untreated group. Analysis of membrane thickness revealed a significantly thinner membrane in EM-treated group compared with untreated group and saline control (p<0.05).

The results of this study seem to indicate that an EM coated Ti pin provided a sufficient drug source to effectively treat wear debris-induced periprosthetic inflammation and osteolysis.
USE OF WAGNER SELF-LOCKING STEM WITH ALLOGRAFT FOR RECONSTRUCTION OF FEMORAL BONE DEFECT DURING REVISION SURGERY

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Several stems have been used for revision of total hip replacement (THR). Moreover, management of proximal femoral bone loss at the time of revision THR remains one of the challenges for hip surgeons. Recently, impaction bone grafting has been suggested to resolve this problem, but it is a demanding technique that results in frequent complications.

We have used the Wagner self-locking stem with cancellous chip allograft for reconstruction of proximal femoral bone defect during revision surgery since 1992. This study evaluated the midterm results of using Wagner revision stem with bone allograft for femoral revision of THR. We could evaluate forty-one femoral revisions performed between 1992 and 2005 using Wagner revision stem with bone allograft. All patients had been followed for a minimum of three years with a mean follow-up of 8.6 years. Preoperative radiological femoral bone defects were assessed and classified by Gustillo’s classification. Subsidence of the stem was measured on radiograms taken immediately after revision surgery and again at the latest follow-up. Femoral component fixation was graded as radiographic ingrowth, fibrous stable, or unstable according to the criteria described by Engh et al. The incidence of surgical complications was examined. Allografts were assessed for incorporation into host bone as evidenced by trabecular bridging of the host-graft interface. A clear reduction in density or breakdown of the allograft was defined as bone resorption. Kaplan-Meier survival analysis was performed. The end point was revision because of mechanical loosening of the stem.

Bone defects were classified as: 10 hips type I, 20 hips type II, and 7 hips type III and 4 hips were a periprosthetic fracture. Subsidence was measured at the time of last follow-up in six hips (3, 3, 12, 16, 21, 30 mm). At the latest follow-up 37 of 41 stems were stable. Allograft incorporation could clearly be observed in the proximal femoral bone defects of 31 stems. Three stems were defined as showing bone resorption. Surgical complications included 11 intraoperative fractures, two femoral shafts were perforated during reaming, one dislocation postoperatively, and 3 greater trochanter pseudoarthroses. There was one deep infection, and these cases were excluded from survivorship analysis. One unstable stem and one stem with infection had to be revised. Kaplan-Meier survival was 97.1 % at 10 years.

Wagner self-locking stem with allograft for reconstruction for proximal femoral bone defect in revision surgery is a beneficial procedure. However, because there is a high incidence of intraoperative fractures, surgery should be performed carefully.
A MULTICENTER STUDY OF IN VIVO KINEMATICS OF A ROTATING PLATFORM POSTERIOR STABILIZING TKA DESIGNED TO REDUCE CONTACT STRESS
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Subjects having a posterior cruciate ligament sacrificing (PCLS) mobile bearing TKA seem to experience less translation during gait, but often achieve less weight-bearing flexion. More recently, posterior stabilisation has been added to PCLS mobile bearing TKA, hoping to increase flexion. Therefore, the objective of this multicenter study was to determine the in vivo kinematics for subjects implanted with a mobile bearing PS TKA that attempts to maintain high contact area.

Subjects with 10 TKA from 2 surgeons were asked to perform maximum weight-bearing flexion (deep knee bend (DKB)) and gait while under fluoroscopic surveillance. During weight bearing flexion, the 3-D kinematics of the TKA were determined by analyzing fluoroscopic images in the sagittal plane at 30 degree increments. Fluoroscopic images taken in the frontal plane from four increments during the stance phase of gait were analyzed.

The average weight-bearing flexion was 116 degrees and the average medial and lateral anteriorposterior (AP) translation was posterior with -1.9 mm and -5.4 mm, respectively, from full extension to maximum weight-bearing flexion.

The average femorotibial axial rotation from full extension to maximum weight-bearing flexion was 3.9 degrees. During the stance phase of treadmill gait, patients experienced 0.8 mm (0.1 mm to 2.3 mm, SD=0.8 mm) of “pure” mediolateral translation of the femur relative to the tibia. The femorotibial axial rotation was 4.6 degrees from heel-strike to toe-off (Table 3).

The posterior femoral rollback and axial rotation patterns were similar to the normal knee, albeit experiencing less overall motion. More noticeably, subjects in this study experienced a significantly greater weight-bearing flexion than previous subjects analyzed with a mobile bearing PCLS TKA and more reproducible “fan-like” patterns, where the lateral condyle rolled greater posteriorly than the medial condyle.
THE MIDTERM RESULT OF 2ND GENERATION METAL-ON-METAL THA IN YOUNG PATIENT
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The aim of the present study was to report the midterm follow up results of second generation metal-on-metal cementless total hip arthroplasties in patients younger than 50 years.

From December 1997 and January 2003, 91 metal-on-metal cementless primary total arthroplasties in 77 patients (who were younger than 50 years) were performed in our institution. Among them 72 hips in 63 patients could be followed more than 5 years. There were 18 women (22 hips) and 44 men (50 hips) with a mean age at surgery of 39 years (range 22 to 49 years) and a mean follow up of 7 years (range 5 to 10 years).

The most common cause of total hip replacement were avascular necrosis of femoral head (37 hips in 28 patients, 51%) and second one was osteoarthritis (13 hips in 13 patients, 18%). We used Fitmore (Zimmer, Winterthur, Switzerland) cup in all cases and used 28mm Metasul femoral head. About the femoral stem, CLS (Protek AG/Zimmer, Bern, Switzerland) stems were used in 48 hips and Cone prosthesis® (Protek AG, Berne, Switzerland) were used in 24 hips.

We evaluated clinical result using Harris hip score (HSS) and the Western Ontario and McMaster Universities Osteoarthritis index (WOMAC) score and radiological evaluation was done using the method of DeLee and Charnley for the acetabular osteolysis and method of Gruen et al. for the femoral osteolysis. The mean HSS improved from 58.9 (range 35 to 69) preoperatively to 92.2 (range 82 to 100) postoperatively. The mean WOMAC score improved from 72.2 (range 63 to 94) preoperatively to 29.2 (range 17 to 51) postoperatively. In radiological evaluation, all femoral and acetabular component were well fixed without loosening or subsidence. But osteolysis was observed in 10 (14%) of total 72 hips (Acetabular osteolysis in 5 cases-Zone 2; 2, Zone 3; 3, Femoral osteolysis in 6 cases-Zone 1; 6, Zone 7; 1).

About the major complications, there were immediate postoperative deep infection 1 case, delayed infection 1 case and recurrent dislocation 1 case. There was no revision case due to aseptic loosening.

The treatment of second generation metal-on-metal cementless total hip arthroplasties in patients younger than 50 years showed favorable midterm results.
SPECIAL FEATURES OF SURGICAL REVISION OF CERAMIC-ON-CERAMIC BEARINGS: A CASE STUDY
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INTRODUCTION: While an increasing number of authors have reported on the long-term results of primary alumina total hip arthroplasty (THA) [1], strategies for revising a ceramic-on-ceramic THA are debated in the literature. According to some authors [2], the reimplantation of a ceramic head on a well-fixed femoral stem is inadvisable, as it may lead to a fracture of the newly implanted head. The aim of the present study was to evaluate the incidence of this specific issue, and to report on the clinical and radiological results of the revised hips.

METHODS: Between January 1977 and December 2005, 138 consecutive alumina-alumina revision hip arthroplasties were performed in 127 patients. There were 79 women (62.2%) and 48 men (37.8%), with an average age of 67 years (range, 32-91 years). Among these, an isolated acetabular revision was performed in 108 cases. The reason for revision was aseptic loosening of the acetabular component in 98 hips, pain in 7, fracture of an alumina liner in 2, and recurrent dislocation in 1. The revised socket was a cemented alumina in 56 hips, a threaded screw-in titanium with an alumina core in 34, a pressfit titanium with an alumina core in 11, and bulk alumina in 7. Acetabular bone stock losses were classified according to the AAOS system. Most of the hips had a contained type II defect (86%). In all cases, the femoral stem was left in place and the acetabular component alone was revised. At the time of revision surgery, an alumina-alumina combination was implanted in 27 hips, an alumina-polyethylene combination in 56, a metal-polyethylene combination in 15, and a zirconia-polyethylene in 10. Overall, a ceramic head was reimplanted on a used femoral taper in 59 cases. Acetabular reconstruction with allografts supported with the Kerboull acetabular reinforcement device was performed in 31% of the hips.

RESULTS: The mean follow-up period was 78 ± 37 months. Thirteen patients (15 hips) died a mean 37 months after surgery. Sixteen patients were lost to follow-up. Postoperatively, five hips had a recurrent dislocation, 2 a deep infection, 9 a trochanteric nonunion (21.3%), 6 a transient nerve palsy. 18 hips required a re-revision surgery, 12 of which for aseptic loosening of the acetabular component. Among the 59 ceramic heads implanted on a well-fixed stem, no fracture of the head occurred at a mean 81 months follow-up. Of the original 108 hips, 77 were available for clinical evaluation and 75 for radiological evaluation at least 2 years after surgery. The mean Merle d’Aubigné score increased from 10.1 ± 2.1 to 16.7 ± 1.1 at the latest follow-up ($p<0.001$). Forty-five hips were graded excellent or very good (60%), 26 good (34.6%), 3 fair (4%), and 1 poor (1.3%). When revision for aseptic loosening was considered as a failure, the overall survival rate at 8 years was 96.3 ± 1.8%.

DISCUSSION & CONCLUSIONS: In the present study, aseptic loosening of the acetabular component was the main reason for revision surgery. Osteolysis around ceramic implants was moderate and was related to the migration of the socket. Among the ceramic heads implanted on a used titanium trunnion, no fracture was observed. This approach is possible, in so far as careful inspection does not show any major imperfection of the morse taper [3]. As for other bearing surfaces, the management of aseptic loosening of al-al prostheses is based on the amount of osteolysis around the loosened socket.

TREATMENT OF LARGE PROTRUSIO DEFECTS IN REVISION TOTAL HIP ARTHROPLASTY. A “CUP IN CUP” CONSTRUCT.
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Introduction: Failure to restore offset in severe protrusio defects in revision total hip replacement can lead to impingement and loss of limb length. The purpose of this study was to determine the initial results obtained with a novel cup in cup technique utilizing two porous tantalum acetabular shells, one placed onto supportive host bone in a cementless fashion, the other cemented in to this shell.

Methods: Porous tantalum hemispherical shells were implanted in 4 revision total hip replacements in 3 patients with an average age of 73 years at the time of the procedure. Bony defects per the Paprosky classification were one IIC, two IIIA, and one IIIB. All patients were followed clinically and radiographically.

Results: The patients were followed for an average of 25.5 months (range, 17 to 29 months). Abductor strength improved by one grade in all patients. In the non-bilateral reconstruction patients horizontal offset was increased compared to the normal hip by 6 mm (IIIB) and 8 mm (IIC). For the bilateral reconstruction patient (IIIA) horizontal offset compared to pre-op was increased by 13-16 mm. There was no evidence of loosening or migration at the time of final follow-up.

Conclusions: At short term follow-up the early experience cautiously supports the use of this construct. Long term follow-up and a larger patient experience will be required to evaluate the results of this novel technique.
REVISION ARTHROPLASTIES OF SIXTY NINE CASES AT PHILIPPINE ORTHOPEDIC INSTITUTE (1984-2007)
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Several hundred Joint Replacement Surgeries have been done by surgeons (Gustilo/Leagogo) of the Philippine Orthopedic Institute in the Philippines since its inception over 20 years ago. Revision surgery of failed cemented hip replacement, have been increasing in the last decade, which is the subject of this report. The average total cost of revision hip surgery in the Philippines ranges from PEP 800 000 to PEP 1 000 000 or USD 20 000 to USD 25 000.

All medical records of the patients were reviewed to determine the following: 1. Etiology 2. Duration from index surgery 3. Common anatomical pathology and amount of leg length discrepancy encountered. 4. Revision implants used and use of allograft. 5. Postoperative course and complications 6. Preliminary results (How many are ambulatory with or without assistive device). 7. Analysis of x-ray at last follow-up.

A total of sixty nine (69) patients were included in the study. Sixty eight percent (68%) of the patients (47 out of 69) underwent revision due to aseptic loosening of components (femoral or acetabular). Nine (9) patients (13%) developed infection. Six (6) patients (9%) developed protrusio acetabuli that necessitated revision. Periprosthetic fracture was noted in four (4) patients (6%). Three (3) patients had hip dislocation (4%) prior to revision. Average number of years from index surgery is 9 years (2-18years). Fifty nine (59) patients (86%) underwent cemented total hip prior to revision while ten (10) patients (14%) underwent cemented partial hip replacement prior to revision. Fifty six (56) patients (81%) have shortening on the affected side with an average of 3cm (1-6cm). Forty five (45) patients (65%) had proximal femoral bone loss requiring structural allograft. Thirty one (31) patients (45%) had acetabular defect (Paprosky Types I & II). In sixty five (65) patients (94%), Active LockTM Cementless Hip Revision System was used. All patients were allowed full weight-bearing after revision surgery. Four patients (6%) developed acute post-op infection. Two patients (3%) had dislocation after revision surgery. At short-term follow-up of one year or more, only 5 patients were ambulating with assistive device. The rest are ambulatory, without aid and are symptom free. Follow-up radiographs showed implants in excellent alignment, no signs of loosening, migration or subsidence.

The main reason for revision hip arthroplasty in the Philippines is aseptic loosening (68%) followed by infection (13 %). The use of long non-cemented, calcarreplacing curved revision stem, and strut allograft on the femoral side; jumbo, cementless acetabular socket and a high hip center on the acetabular side, addressed the problem of anatomic pathologies as a result of failed, cemented THR. There is no association between cause for revision with gender and age of the patients.
IN VIVO WEAR OF HIGHLY CROSS-LINKED POLYETHYLENE ACETABULAR CUP AGAINST ALUMINA CERAMIC HEAD BY RADIOGRAPHIC AND RETRIEVAL ANALYSIS

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In total hip arthroplasty (THA), one of concerned issues is osteolysis due to wear debris of ultra-high molecular weight polyethylene (PE) which often leads to aseptic loosening. Reduction of PE wear debris is essential to prevent osteolysis, and different bearing combination as well as improvement of the bearing material itself have been attempted. Hence alumina ceramics was introduced for THA, aiming to reduce PE wear debris. Ceramic on PE couple showed good results in clinical wear compared with metal on PE couples. Highly cross-linked PE (HXLPE) with gamma-ray or electron-beam irradiation followed by thermal treatment has also demonstrated a remarkably low wear in the previous in vitro studies. In in vivo studies, the wear of HXLPE acetabular cups against alumina ceramic femoral head was evaluated to compare with that of conventional PE cups against alumina ceramic femoral head.

The in vivo wear of 61 HXLPE cups (Aeonian; Kyocera Corp., Kyoto, Japan, currently Japan Medical Materials Corp., Osaka, Japan) against alumina ceramic femoral head of 28 mm in diameter with clinical use for 2.1–7.1 years (mean 5.6 years) and eight conventional PE cups against an alumina ceramic femoral head of 28 mm in diameter used for 18.7–23.3 years (mean 20.4 years) were examined by radiographic analysis with Vector Works 10.5. In the in vivo studies, the wear of HXLPE acetabular cups against alumina ceramic femoral head was evaluated to compare with that of conventional PE cups against alumina ceramic femoral head.

In the radiographic study, penetration rate of alumina head into HXLPE and conventional PE for the first 1 year were 0.24 mm/year and 0.34 mm/year respectively. One year later, the HXLPE showed significant lower penetration rate of 0.001 mm/year than the conventional PE penetration rate of 0.12 mm/year ($p<0.01$). By the retrieval analysis, the mean penetration of retrieved HXLPE and conventional PE cups were 0.11 and 2.97 mm, and they were similar to the results by radiographic analysis. In the worn surface of the retrieved HXLPE cups used for around 1 year, machine marks were observed. In contrast, the worn surface of the retrieved HXLPE cups used for more than five years were smooth, and furthermore, in high magnification observation they had wear morphology different from conventional PE. These findings from this retrieval study suggest the penetration in the first 1 year detected by radiographic measurement was probably caused by creep deformation in bedding-in stage; and 1 year after, the penetration was probably caused mainly by wear.

By the radiographic analysis, HXLPE cups against alumina ceramic femoral head has a 99% lower wear rate compared with conventional PE cups. Also, retrieved HXLPE cups against alumina ceramic femoral head exhibited lower wear compared with conventional PE cups. In conclusion, we expect that the HXLPE cup used with alumina ceramic femoral head has favorable wear properties in long-term clinical use.
PRE-Clinical RESULTS OF PORous TITANIUm PARTICLES IN CEMENTed IMPACTION Grafting HIP ReviSion ARTHROPLASTY

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Bone impaction grafting (BIG) is a surgical technique for the restoration of bone stock loss with impaction of autograft or allograft bone particles (BoP). The goal of a series in-vitro and in-vivo experiments was to assess the suitability of deformable pure Ti (titanium) particles (TiP, FONDEL MEDICAL BV, Rotterdam, The Netherlands) for application as a full bone graft substitute in cemented revision total hip arthroplasty. TiP are highly porous (interconnective porosity before impaction 85 to 90%). In-vitro acetabular reconstructions were made in Sawbones (SAWBONES EUROPE, Malmö, Sweden) to evaluate migration by roentgen stereo photogrammetric analysis and shear force resistance by a lever out experiment. In-vitro femoral TiP reconstructions (SAWBONES, Malmö, Sweden) were used to evaluate micro-particle release and subsidence. Mature Dutch milk goats were used for two in-vivo experiments. 1. A non-loaded femoral defect model was used to compare osteoconduction of bioceramic coated TiP with BoP and ceramic particles (CeP). 2. Acetabular defects (AAOS type 3) were reconstructed in 10 goats using a metal mesh with impacted TiP acting as a full bone graft substitute in combination with a cemented polyethylene cup and a downsized cemented Exeter femoral stem (STRYKER BENOIST, Girard, France). Blood samples were taken for toxicological analysis.

In-vitro: TiP were as deformable as BoP and created an entangled graft layer (porosity after impaction 70 to75%). Acetabular TiP reconstructions were more stable and resistant to subsidence and shear force than BoP reconstructions (lever-out moment 56 ± 12 Nm respectively 12 ± 4 Nm, p < 0.001). After initial setting, femoral subsidence rates were smaller than seen in femoral bone impaction grafting (0.45 ± 0.04 mm after 300 000 loading cycles). Impaction generated 1.3 mg particles / g TiP (particle Ø 0.7-2 000 μm, tri-modal size distribution). In-vivo: Bioceramic coated (10 - 40 μm) TiP showed bone ingrowth rates comparable to BoP and CeP. Reconstructed acetabular defects showed rapid bone ingrowth into the layer of TiP. Serum titanium concentrations slowly increased from 0.60 ± 0.28 parts per billion (ppb) preoperatively to 1.06 ± 0.70 ppb at fifteen weeks postoperatively (p = 0.04).

Mechanical studies showed very good initial mechanical properties of TiP reconstructed defects. The in-vitro study showed micro-particle generation, but in the shortterm goat studies, histology showed very few particles and no negative biological effects were found. The in-vivo acetabular study showed very favorable bone ingrowth characteristics into the TiP layer and a much thinner interface with the cement layer compared to similar defects reconstructed with BoP or mixtures of BoP with CeP. Further analysis in a human pilot study should proof that TiP is an attractive and safe alternative for allograft bone in impaction grafting revision arthroplasty.
CHANGES IN D-DIMER LEVEL FOLLOWING TOTAL HIP ARTHROPLASTY - EFFECT OF ANTICOAGULATION DRUGS
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We used the D-dimer level as a measure for the early diagnosis of deep vein thrombosis (DVT), which can cause fatal pulmonary thromboembolism (PTE), following total hip arthroplasty (THA). Recently, we have performed anticoagulation therapy, in addition to the use of elastic stocking and intermittent pneumatic compression, for the prevention of DVT. In the present study, we examined the effect of administration of anticoagulation drugs on the changes in the D-dimer level.

Of 123 patients who had undergone THA between April 2003 and October 2007, 70 patients who were available for 3 or more measurements of the D-dimer level were included in this study. These 70 patients were divided into the following three groups: N group consisting of 30 patients who were not given anticoagulation drugs (4 males, 26 females; mean age 69 years (45-87 years); mean body mass index (BMI) 24.1 (15.8-28.5)), W group consisting of 23 patients who were administered dose-adjusted warfarin at a dose of 5 mg within 3 days after surgery and at 1-3 mg following 1-day rest (3 males, 20 females; mean age 62 years (48-83 years); mean BMI 24.1 (17.8-35.9)), and F group composed of 15 patients who were given fondaparinux (2.5 mg) between postoperative days 1 and 14 (6 males, 11 females; mean age 64 years (51-81 years); mean BMI 23.1 (18.2-31.6)). There was no significant difference in sex ratio and BMI between the three groups, while a significant difference in age was found between the N and F groups. The D-dimer level was measured on days 3, 7, 10, 14 and 21 and changes in the median D-dimer level were compared between groups.

In the N group, the D-dimer level was around 8 μg/ml between postoperative days 3 and 10 and exceeded 10 μg/ml on postoperative day 14. In the W group, the D-dimer level was around 8 μg/ml between postoperative days 3 and 14 and decreased thereafter. In the F group, the D-dimer level was less than 3 μg/ml on postoperative day 3, increased gradually thereafter until postoperative day 14, reaching the maximum level of approximately 8 μg/ml, and then decreased thereafter.

The D-dimer level was significantly different between the N and F groups and between the W and F groups on day 3, between the N and F groups and between the W and F groups on day 7, and between the N and W groups on day 21. With regard to hemorrhagic adverse events, neither major nor minor bleeding event was observed in either the W or F group.

The present study suggested that fondaparinux is effective for preventing DVT in an early postoperative period, with relatively low D-dimer levels observed between postoperative days 3 and 10.

We expect that various types of anticoagulation drugs will be used in the future. Elucidating the effect of these drugs on the D-dimer level will help in the early diagnosis of DVT.
COMPARISON OF IN VIVO THREE DIMENSIONAL KINEMATICS DURING DEEP KNEE BENDING BETWEEN FIXED BEARING AND MOBILE BEARING AFTER HIGH-FLEX POSTERIOR STABILIZED TOTAL KNEE ARTHROPLASTY

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Recently mobile-bearing total knee arthroplasty (TKA) has become more popular. However, the advantages of mobile bearing (MB) PS TKA still remain unclear especially from a kinematic point of view. The objective of this study was to investigate the difference and advantage in kinematics of mobile baring PS TKA compared with fixed bearing (FB) PS TKA.

Femorotibial nearest positions for 19 subjects (20 knees), 10 knees implanted with NexGen Legacy flex (Zimmer, Warsaw, IN) with mobile bearing PS TKA, and 10 knees implanted with NexGen Legacy flex (Zimmer, Warsaw, IN) with fixed bearing PS TKA were analyzed using the sagittal plane fluoroscopic images. All the knees were implanted by a single surgeon. All the subjects performed weight bearing deep knee bending motion. We evaluated range of motion, axial rotation of the femoral component, AP translation of medial and lateral sides.

The average range of motion between femoral component and tibial component was 119°±18° in MB and 122°±10° in FB. The axial rotation of the femoral component was 11.8°±6.2° in MB and 11.8°±4.9° in FB. There was no significant difference both in range of motion and axial rotation between MB and FB. The AP translation of MB and FB showed same patterns. They were rollback in early flexion, the lateral pivot pattern (the medial condyle moved forward significantly compared with the lesser amount of AP translation for the lateral condyle) at mid flexion, and bicondylar rollback at deep flexion. The rollback in early flexion was 3.4mm in MB and 1.8mm in FB at medial side, 4.2mm in MB and 4.8mm in FB at lateral side. There was no significant difference. The lateral pivot pattern, which moved anteriorly, was 7.8mm in MB and 7.0mm in FB at medial side, 3.0mm in MB and 2.4mm in FB at lateral side. There was no significant difference. The bicondylar rollback at deep flexion was 6.4mm in MB and 7.7mm in FB at medial side, 6.9mm in MB and 4.8mm in FB at lateral side. In four subjects, more than 12° axial rotation was observed in knees implanted with FB TKA which allows only 12° axial rotation.

The results in this study demonstrate that there was no significant difference in kinematics of weight bearing deep knee bending motion between MB and FB. The advantage of MB is allowance of axial rotation which restricted until 12° in FB NexGen Legacy flex PS TKA.
BODY MASS INDEX COMPARISON OF KNEE KINEMATICS FOR OBESE, OVERWEIGHT AND NORMAL WEIGHT TKA SUBJECTS
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All over the world, obesity rates are on the rise. Medical complications and increased health risks are often associated with being overweight or obese, but a thorough understanding of in vivo motions for obese, overweight and normal weight subjects does not exist. Therefore, the objective of this study was to compare knee kinematics in TKA subjects by body mass index (BMI).

In vivo knee kinematics were determined for 253 TKA subjects during a Deep Knee Bend (DKB) from full extension to maximum flexion using a 3D to 2D image registration technique. Each of these subjects was then classified into one of three BMI categories: obese (BMI greater than or equal to 30), overweight (BMI greater than or equal to 25 and less than 30) and normal weight (BMI less than 25 and greater than or equal to 18.5). Subjects were provided by 11 surgeons using ten different TKA devices. All subjects were deemed clinically successful.

On average, weight bearing range of motion (ROM) for the obese (n=79), overweight (n=113) and normal weight (n=61) groups were 107.7° (range: 74° to 136°, standard deviation (σ) =14.9°), 109.6° (60° to 150°, σ=17.5°) and 114.1° (72° to 147°, σ=14.4), respectively. ROM of 90° or less was seen in 16.5% of the obese subjects, 14.2% of the overweight subjects and 6.6% of the normal weight subjects. ROM of 125° or more was seen in 15.2% of the obese subjects, 16.8% of the overweight subjects and 23.0% of the normal weight subjects.

From full extension to maximum flexion the obese, overweight and normal weight groups averaged 8.65° (-5.14° to 22.51°, σ=6.22°), 7.58° (-2.85° to 24.72°, σ=5.71°) and 5.72° (-4.84° to 19.43°, σ=5.65°) of axial rotation. Axial rotation of 3° or less was seen in 20.25% of the obese subjects, 23.01% of the overweight subjects and 39.34% of the normal weight subjects. Axial rotation of greater than 9° was seen in 51.90% of the obese subjects, 35.40% of the overweight subjects and 26.23% of the normal weight subjects. Opposite axial rotation was seen in 8.86% of the subjects in the obese group, 9.73% of the overweight group and 9.84% of the normal weight group.

On average, from full extension to maximum flexion, the medial condyle for the obese, overweight and normal weight groups experienced -5.44mm (-22.20mm to 8.04mm, σ=7.9mm), -6.30mm (-25.22mm to 5.35mm, σ=7.36mm) and -4.78mm (-20.79mm to 5.49mm, σ=6.68mm) of posterior femoral rollback (PFR), respectively. The obese, overweight and normal weight groups averaged -12.66 mm (-34.57mm to 0.34mm, σ=9.32mm), -12.38mm (-36.72mm to 1.83mm, σ=10.33mm) and -9.39 mm (-34.55mm to 0.35mm, σ=8.98mm) of lateral PFR, respectively.

Condylar lift-off of greater than 1mm was seen in 16.46% of obese subjects, 10.62% of overweight subjects and 11.48% of normal weight subjects.

Various statistical differences were seen across the groups. The normal weight subjects had significantly higher ROM that the obese subjects (p=0.0184), while there was no difference seen between the normal weight and overweight groups or the overweight and obese groups. The obese and the overweight groups had significantly more axial rotation than the normal weight group from 0° to 90°, 0° to maximum flexion, 30° to 90°, 30° to maximum flexion and 60° to 90°. There were a significantly higher number of cases of condylar lift-off for obese subjects when compared to both normal weight and overweight groups.

It can be concluded that body mass index does play a factor in TKA kinematics.
EFFECT OF BEARING MATERIAL AND SIZE ON TOTAL HIP REPLACEMENTS:
COMPARISON OF 14 DIFFERENT DESIGNS UNDER THE SAME TESTING CONDITIONS

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Sub-micron polyethylene particles produced by the wear of metal on ultra-high molecular weight polyethylene (UHMWPE) in artificial joints have been identified as a principle culprit in the osteolysis frequently found in the bone surrounding these implants. To eliminate UHMWPE debris, highly crosslinked (HXL) UHMWPE and hard-on-hard bearing surfaces have been developed. This study compares the wear rates of 14 designs and/or material combinations (total of 48 specimens) tested on a hip simulator in the biomechanics lab at the University of Nebraska Medical Center.

Twelve ceramic-on-metal (COM) (six 36mm and six 28mm, of high and low clearance (HC, LC)), twelve metal-on-metal (MOM) (44mm, 3 TiN coated, 3 uncoated standard, and 6 resurfacing components), eighteen metal-on-UHMWPE (MOP) (36mm: six with CoCr-coated heads and six uncoated standard heads with conventional UHMWPE; 44mm: 3 conventional UHMWPE and 3 HXL), and six ceramic-on-UHMWPE (COP) (three 44mm and three 32mm all with conventional UHMWPE) were tested on a multi-station hip simulator (AMTI, Boston). The specimens were lubricated with bovine serum diluted to 20g/l protein concentration at 37°C and were subjected to the loading and rotations of the walking cycle as specified in ISO-14242-1 at 1Hz (for 5 million cycles (Mc) except where specified otherwise). The liners (and heads where specified) were cleaned and weighed at 0, 0.25, 0.5, and every 0.5Mc afterwards.

For 36mm COM liners the wear rates of HC and LC were the lowest observed (-0.019±0.118mg/Mc and -0.061±0.044mg/Mc, respectively). All three 28mm COM HC and one LC liner exhibited “break-away” wear in that they would lose several milligrams (HC: 5.99mg, 6.37mg, 8.50mg, LC: 10.22mg) after showing nearly no measurable wear (HC: 0.905±0.467mg/Mc, 28mm LC: 0.422±0.982mg/Mc). (Note that COM heads weighs were not quoted here but none of them lost weight). TiN-coated MOM THRs (heads and liners) showed higher wear than the uncoated MOM THRs (8.53±4.07mg/Mc, 3.19±0.281mg/Mc, respectively) as the TiN wore away from all three coated heads and liners. The MOM resurfacings components showed wear rates of 2.77±1.27mg/Mc over 2Mc. The 36mm MOP liners (CoCr-coated and uncoated heads) showed wear rates of 55.6±4.26mg/Mc and 44.5±4.46mg/Mc, respectively, as the coating wore away from the metal heads. Wear rates of the 44mm MOP conventional and HXL liners were 72.0±2.81mg/Mc and 14.2±3.57mg/Mc respectively. For COP, the larger size wore at a higher rate than the smaller size (44mm: 97.4±3.08mg/Mc, 32mm: 51.3±12.2mg/Mc) over 2Mc. The 44mm COP THR displayed the highest observed wear rate.

Our simulator results confirm low wear for hard-on-hard bearing couples (MOM, COM) except where coating failure had occurred. Size-36mm LC COM bearings fared the best of the four COM types tested (showing no measurable wear and no “break-away” wear). MOP THRs showed better wear performance when HXL UHMWPE was used, and also showed a sensitivity to femoral head coating removal. COP THRs showed high wear in the large 44mm size, and less in the smaller size. Simulator wear testing was able to successfully discriminate and characterize wear rates of different material bearing couples and different sizes/designs.
CORRELATION OF FRICTION MEASUREMENTS WITH WEAR CHARACTERISTICS DURING MULTI-STATION HIP SIMULATOR WEAR TESTS

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With the boom in metal-on-metal hip resurfacing and hard-on-hard total hip replacements (THRs) with extremely low wear, accurate tribological measurements become difficult. Characterizing THR friction can help in this, especially if the progress of such friction can be tracked during wear tests. Friction measurement can also be used as a tool to study the effects of acetabular-liner deformation during insertion, and possible femoral head “clamping”. This study presents estimates of friction during extended wear testing on THRs of the same size but with different material combinations, using a technique (previously introduced) based on equilibrium of forces and moments measured in the simulator.

All tests were based on five million cycles (Mc) and samples of size-44mm (head diameter). Samples included 6 metal-on-UHMWPE (MOP) (3 with conventional UHMWPE and 3 with highly-cross-linked (HXL) UHMWPE liners), 6 metal-on-metal (MOM) (3 TiN-coated and 3 uncoated), 6 MOM resurfacing (3 standard and 3 with small pockets for lubrication transport), and 3 ceramic-on-UHMWPE (COP) THRs (MOM resurfacing and COPs for 2Mc only). All were lubricated with diluted bovine serum with 20g/l protein concentration at 37°C, and subjected to the loading and rotations of the walking cycle in ISO-14242-1 on a twelve-station hip simulator (AMTI, Boston).

The conventional and HXL MOPs had steady friction factors of 0.045±0.009 and 0.046±0.003 over 5Mc, explained by the stability of wear rates of both these MOP types (72.0±2.81mg/Mc and 14.2±3.57mg/Mc, respectively). However, during the “bedding-in” period (first 0.5Mc), the conventional MOP friction factor rose from 0.047±0.004 to 0.057±0.004 while high wear was occurring (147.1±10.08mg/Mc). The TiN-coated and uncoated MOMs displayed initial friction factors of 0.124±0.117 and 0.039±0.003 respectively. The high standard deviation for the coated THRs was due to coating removal on one specimen which caused scratches and scuffs on its articulating surfaces. This specimen had a friction factor of 0.260 at 0.028Mc. By 1Mc, the TiN coating wore away on the other two coated specimens (friction factors at 1Mc: coated 0.081±0.036, uncoated 0.050±0.014). Over the 5Mc test, average friction factors for the coated and uncoated THRs were 0.097±0.020 and 0.049±0.014 respectively. The 44mm standard and “pocketed” MOM resurfacing THRs displayed initial friction factors of 0.038±0.009 and 0.059±0.026 respectively that increased to the same level at 2Mc (0.094±0.020 and 0.094±0.029, respectively). No difference in wear was detected between the two resurfacing head types (wear rates over 2Mc: standard 3.32±0.25mg/Mc, pocketed 2.22±1.76mg/Mc), but curiously, both types exhibited an equal level of scratching and scuffing on their articular surface. Finally, the three COP THRs exhibited high liner wear over 2Mc (97.44±3.08mg/Mc), which slowed after the “bedding-in” period. The friction factor also decreased from 0.091±0.005 to 0.070±0.008 over the same period as the UHMWPE liner conformed to the ceramic head.

The method utilized here facilitates on-line sampling throughout the progress of a prolonged wear test, and therefore allows predictions on THR performance/wear to be made. When high friction factors were observed, a high wear rate was occurring and measured on the THR specimens, or damage to articulating surfaces was seen.
OPTIMAL DURATION OF CONTINUOUS FEMORAL NERVE BLOCK AFTER TOTAL KNEE ARTHROPLASTY

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Purpose: Continuous femoral nerve block (CFNB) has been revealed to be a safe and effective method to decrease postoperative pain after total knee arthroplasty (TKA). However, optimal duration for CFNB to decrease pain and accelerate rehabilitation program after TKA has not been addressed. We, therefore, compared three groups of patients which had different duration of CFNB (0, 2, and 5 days) in this study.

Methods: Sixty patients who received primary TKA for osteoarthritis were divided into three groups based on the duration to receive CFNB for 0 day, 2 days or 5 days (twenty patients for each group). Ropivacaine 2 mg/mL was given through the femoral nerve catheter using elastomeric infusers (delivering 2 ml/hr for each group). Outcomes including visual analog scale (VAS) pain scores and range of motion (ROM) were compared at 1st, 3rd, 6th, 14th and 21th days after surgery. In addition, the postoperative date when patients could walk stably with parallel bar, walker, or T-cane were recorded and compared.

Results: At 1st and 3rd day postoperatively, the VAS was significantly better in the CFNB 2 days and CFNB 5 days group than in the CFNB 0 day group (P<0.05). ROM did not show significant difference among the three groups over postoperative days 1st to 21st (P>0.05), although groups with the CFNB showed greater ROM at all time points. The CFNB 5 days group obtained stable walking ability with T-cane earlier than other groups (P<0.05). No patient had any side effect by having CFNB in this study.

Discussion: Postoperative use of CFNB reduced pain at first 3 days, and shorten the time to acquire stable walking ability after TKA. We conclude that CFNB should be kept for 5 days after surgery to decrease pain and accelerate rehabilitation program after TKA.
FIVE-YEAR WEAR COMPARISON OF LONGEVITY HIGHLY CROSS-LINKED POLYETHYLENE SOCKET AGAINST 26 MM AND 32 MM COBALT-CHROMIUM HEADS

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Using a larger diameter femoral head in total hip arthroplasty (THA) has advantages in terms of the increased joint stability and range of motion. And the wear resistance of highly cross-linked polyethylene (HXLPE) even combined with a larger head has already been demonstrated by in vitro studies. The purpose of this study was to compare the in vivo wear of Longevity HXLPE sockets against 32 mm and 26 mm heads at a 5-year follow-up.

From November 2000 to November 2001, 51 primary cementless THAs were performed with a 26 mm cobalt-chromium head and a Longevity HXLPE socket (Zimmer). A cohort of 32 mm cobalt-chromium heads was comprised of 51 THAs with the same prosthesis performed from December 2001 to December 2003. No significant differences between the groups were observed in gender, age, and BMI, however, polyethylene liners with 32 mm heads were significantly thinner than those with 26 mm heads. Two-dimensional linear wear was measured using PolyWare software on annual x-rays, and total head penetration rates at postoperative 5-year and steady state wear rates were calculated. In addition, periprosthetic osteolysis was evaluated.

At the 5-year follow-up, the total head penetration rates were 0.047±0.022 mm/year with 26 mm heads and 0.048±0.026 mm/year with 32 mm heads. The steady state wear rates were -0.008 mm/year with 26 mm heads and 0.001 mm/year with 32 mm heads. No significant differences were seen between the two groups (p=0.82 and p=0.24). Osteolysis was not observed around prostheses in any hips.

At the 5-year follow-up, the wear rate of Longevity HXLPE was very low. A Longevity HXLPE socket will undergo the same level of wear whether with a 32 mm head or a 26 mm head.
ALLOGENIC BONE GRAFTS WITH COVALENTLY TETHERED ANTIBIOTICS PREVENT BACTERIAL ATTACHMENT AND BIOFILM FORMATION

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Use of allograft bone has become standard for bridging defects unlikely to heal by simple fixation and routinely used in revision arthroplasties for implant stabilization. Unfortunately, this decellularized allograft provides an ideal surface for bacterial colonization, necessitating repeated surgeries, extensive debridement and lengthy antibiotic treatments. With up to 18% infection rate following allograft surgeries, a need for more effective means to prevent this process is evident. We describe a novel modification of native bone allografts that renders their surface bactericidal while increasing the effectiveness of systemic antibiotic treatments.

Allograft modification: Morselized human bone was washed extensively and sequentially coupled: 2X with Fmoc-aminoethoxyethoxyacetate (Fmoc-AEEA); deprotected with 20% piperidine in Dimethylformamide (DMF); and then coupled with vancomycin (VAN) for 12-16 hours. The VAN-bone was washed extensively with DMF and PBS for at least 1 day. VAN immunofluorescence: Control or VAN-bone was washed 5X with PBS, blocked with 10% FBS (1hr), incubated with rabbit anti-VAN IgG (4oC, 12h) followed by an AlexaFluor 488-coupled goat anti-rabbit IgG (1hr), and visualized by confocal laser microscopy. Antibiotic Activity. Equal dry weights of control and VANbone were sterilized with 70% ethanol, rinsed with PBS, and incubated with either Staphylococcus aureus (S. aureus) or Escherichia Coli (Ci=104 cfu) in TSB, 37oC, for 2, 5, 8 and 12 hrs. Antibiotic treatment: Clinical grade vancomycin was added to the solution with bacteria or following infection at a final concentration of 10 μg/ml. Bacterial counts: Non-adherent bacteria were removed by washing and adherent bacteria suspended by sonication in 0.3% Tween-80 for 10mins followed by plating on 3M® Petrifilms. Bacterial visualization: Non-adherent bacteria were removed by washing extensively with PBS and adherent bacteria stained with the Live/Dead BacLight Kit (20mins, RT) to cause viable bacteria to fluoresce green. Samples were visualized by confocal microscopy.

In comparison to controls, VAN-bone consistently reduced the graft bacterial load by ~90% at all time points. After staining and visualization of adherent bacteria, biofilm formation was apparent on controls by 12 hrs and absent from VAN-bone. E.coli, a gram negative organism that is not sensitive to VAN, readily colonized both control and VANbone, confirming retention of VAN specificity. We then evaluated VAN-bone activity in a system that modeled systemic antibiotic therapy and antibiotic prophylaxis. In the absence of solution antibiotics, VAN-bone exhibited a significant decrease in bacterial colonization as compared to controls. When 10 μg/ml VAN was added to the medium for the last 4 h (modeling systemic antibiotic therapy), colonization of control surfaces was reduced, while colonization of VAN-allograft was almost eliminated. When 10 μg/ml VAN was added concomitantly with S. aureus, VAN-bone colonization was undetectable, while colonization of control surfaces still occurred.

We have previously described an antibiotic-tethered allograft that resists bacterial colonization. In this abstract, we test this technology with an vitro model of bone implantation in the presence of solution antibiotics. In these models, solution antibiotics failed to prevent infection of control bone while completely clearing the bacteria on VAN-bone. Furthermore, VAN bone exhibited high activity against S. aureus, a gram positive organism, whereas it was ineffective against E. coli, a gram negative organism. The specificity of the tethered antibiotic supported the view that the antibacterial properties of the allograft were related to the tethered
antibiotic and not to undefined aspects of the attachment chemistry. In terms of antibacterial activity, when challenged with 104 CFU \textit{S. aureus} (with concentrations reaching >10^7 CFU by 24 h), the antibiotic-modified allograft consistently decreased bacterial colonization by >90%; \textit{S. aureus} inocula <10^2 CFU resulted in no detectable colonization of the VAN-allograft. Thus, development of these allografts may not only combat allograft colonization but increase the effectiveness of prophylactic antibiotics to ultimately result in a new therapy for allograft-associated infection.
ACETABULAR REVISION USING ACETABULAR ROOF REINFORCEMENT RING
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We wanted to evaluate the clinical and radiological results of acetabular revision using the acetabular reinforcement ring and allograft impaction in patients with severe acetabular bony defect.

41 hips revision arthroplasty using reinforcement ring were performed between April 1997 and October 2005 and were followed up for more than two years. The cause of primary arthroplasty was AVN in 18 cases, secondary osteoarthritis (OA) in 17 cases, fracture in cases and primary OA in 1 case. The cause of revision arthroplasty was acetabular cup loosening in 20 cases, massive osteolysis in 14 cases, infection in 4 cases, liner dissociation in 2 cases, and recurrent dislocation in 1 case. The average period between primary and revision arthroplasty was 11.4 years (range 0.6 to 29.1 years ). Acetabular defects were classified based on the AAOS classification and Paprosky classification system. All were treated with autografts or allografts. Muller ring was used in 18 cases, Burch-Schneider ring was used in 14 cases, and Ganz ring in 9 cases. Clinical evaluations were performed according to the Harris hip score (HHS), and the radiographic results were evaluated by progression of acetabular component loosening, union of bone grafts, periacetabular osteolysis, and migration of the hip center.

The mean preoperative Harris hip score of 64.9 was improved to 91.8 points at the latest follow-up. There were 39 cases of type 3 defect, 2 cases of type 4 defect according to the AAOS classification and 8 cases of type 2B defect, 3 cases of type 2C defect, 28 cases of type 3A defect, and 2 cases of type 3B defect according to Paprosky classification. Radiographically, the bone grafts were well united except one case. The mean preoperative hip center of rotation which was vertically 32.3 mm, horizontally 33.2 mm migrated to vertically 26 mm, horizontally 33.2 mm postoperatively and it was statistically significant. The mean preoperative abductor lever arm of 41.7 mm changed to 45 mm postoperatively which was statistically insignificant. However the mean preoperative body lever arm of 89.4 mm changed to 96.9 mm postoperatively which was statistically significant. Postoperative complications were cup loosening in 1 case, dislocation in 2 cases, and recurrence of deep infection in 1 case.

Clinically and radiographically, acetabular reconstruction using reinforcement ring showed very promising short term result. We conclude that reinforcement ring can provide stable support for grafted bone in severe bone defect. But meticulous surgical technique to get initial firm stability of ring and optimal indication in mandactory for the successful result.
A SAFER “PINLESS” TECHNIQUE TO RECONSTRUCT A NEUTRAL MECHANICAL AXIS IN TOTAL KNEE ARTHROPLASTY

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When compared with traditional techniques, computer-assisted total knee arthroplasty (TKA) has been shown to allow more accurate coronal alignment of the implants with fewer “outliers.” Most navigation systems in computer-assisted TKA utilize rigidly-fixed trackers placed on both the femur and tibia, a computer workstation, and navigation software to determine the mechanical axis of the extremity intraoperatively, in real time. The purpose of this study was to report the initial experience of a single surgeon with a novel navigation system. This system utilizes a “pinless” technique using trackers that are mounted at the articular surface of the knee instead of being fixed to the femur and tibia.

Sixty-Six consecutive TKAs were performed using a novel “pinless” navigation system by a single surgeon. At 4 weeks post-operatively, coronal alignment was assessed with long-standing AP radiographs. The alignment measurements were then compared to historical controls.

The average alignment in the coronal plane was 1.73° +/- 1.50° deviation from neutral alignment. Variance was 2.26°. The confidence interval constructed with an alpha value of .05 was (1.50°, 2.40°). Five knees had a coronal alignment greater than 3° from neutral. Of these five, three had an ipsilateral total hip replacement, and 2 were morbidly obese. There were no pin site infections nor pin site fractures. There was 1 late hematogenous infection.

This study reports an initial single-surgeon experience of a novel “pinless” navigation technique for TKA. The technique in this study is a novel and safe method to reconstruct a neutral mechanical axis, as it avoids the morbidity of the application of navigation tracking pins and therefore enhances patient safety.
Placement of total knee arthroplasty components is typically controlled via resections that reference bony landmarks. For example, external rotation of the femoral component can be pre-determined by referencing the posterior condyles or the epicondylar axis. Such approaches exclude consideration of any potential effect of the collateral ligaments before resection are made. In addition, bone referencing instrumentation usually limits femoral component placement to discrete values of external rotation such as 3° or 5°. The purpose of the present study was to determine external rotation of the femoral component following use of a novel ligament balancing approach and to assess the accuracy of balancing the flexion and extension gaps with this ligament balancing system.

One hundred twenty knees in 110 patients were consecutively enrolled by a single surgeon using the same implant across subjects. All patients underwent arthroplasty that set external rotation of the femoral component based upon use of a novel ligament balancing system. Following ligament tensioning / balancing, the femur was prepared. Thicknesses of the medial and lateral posterior condylar resections were measured and the difference between the two measurements was calculated. When placed into relation with the line formed by the distance between the midpoints of the distal condyles (reference line), the difference in the condylar resections gives the height of a right triangle. The arc tangent function was then used to calculate the resultant angle (external rotation) formed from the reference line and the hypotenuse. The average, range and standard deviation of the external rotation values was found.

External rotation averaged 6.9° (+/- 2.8°) and ranged from 0.6° to 12.8°. Fifty-four percent of femoral components were sized 3, 4 or 5. The external rotation values in this study were 4° and 2° larger, respectively, than the typical 3° and 5° discrete values that are common to measured resection systems.

External rotation values are higher on average, when ligament tensioning / balancing is employed with this novel system compared to measured resection systems. Also, the standard deviation and range suggests that true femoral rotation varies greatly between patients. This finding suggests that limiting the surgeon to discrete rotation values may be at odds with where the femur “desires” to be, given soft tissue considerations for each patient. Future work includes determining whether there is a functional difference between measured resection and this ligament tensioning / balancing approach.

The accuracy of the ligament balancing system was assessed by applying equal tension on the ligaments using a tensioning bolt and torque wrench in flexion and extension after the bone resections had been made. The resulting flexion and extension gaps were then measured to determine rectangular shape and equality of the gaps.

Rectangular flexion and extension gaps were obtained within 0.5 mm in all cases. Equality of the flexion and extension gaps was also obtained within 0.5 mm 100% of the time. To the best of our knowledge, this system and technique has produced better accuracy balancing the flexion and extension gaps in total knee arthroplasty than has previous been reported.
DEVELOPMENT AND INTEGRATION OF ULTRA-WIDEBAND WIRELESS TECHNOLOGY FOR COMPUTER ASSISTED ORTHOPAEDIC SURGERY
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Wireless technologies applied to the medical field have grown both in prevalence and importance in the past decade. Various applications and technologies exist underneath the telemedicine umbrella including Point-of-Care systems where electrocardiographs, blood pressure, temperature, and medical image data are recorded and transmitted wirelessly, which enables remote patient monitoring from inside hospitals, personal residences, and virtually any location with access to satellite communication. Another widespread application for wireless systems in hospitals is asset tracking, typically done with RFID technology. Wireless technologies have not been widely used in computer assisted orthopaedic surgery (CAOS) because of the limitations in terms of overall 3-D accuracy.

We have developed a wireless positioning system based on ultra wideband technology (UWB) which achieves mm-range 3-D dynamic accuracy and can be used for intraoperative tracking in CAOS systems. Current intraoperative tracking technologies include optical and electromagnetic tracking systems. The main limitations with these systems include the need for line-of-sight in optical systems and the limited view volume and susceptibility to metallic interference in electromagnetic tracking systems. UWB indoor positioning does not suffer from these effects. Until this point, the main limitation of UWB indoor positioning systems was its limitation in 3-D real-time dynamic accuracy (10-15 cm as opposed to the required 1-2 mm).

We have developed a UWB indoor positioning system which achieves dynamic 3-D accuracy in the range of 5-6 mm for a non-coherent approach and 0.5-1 mm for a coherent approach (transmitter and receiver use the same clock signal). The integration of this tracking system with smart surgical tools opens up a plethora of exciting intraoperative applications including picking landmarks, 3-D bone and instrument registration, real-time wireless pressure sensing used for ligament balancing in TKA, and real-time A-mode ultrasound bone morphing. The UWB tracking system will be presented along with its integration into smart surgical tools and surgical navigation.
Clinical outcomes of UKA procedures are sensitive to malalignment of the components, and thus show significant variability in the literature. This study evaluates the two year clinical results of a new surgical procedure designed to significantly increase the accuracy and precision of the alignment of the components, and thus increase postoperative functional outcomes.

A new UKA technique has been developed, which combines tactile guided robotic technology with image guided surgery. Three-dimensional planning of the implant positioning is followed by precise resection of the bony surfaces. To date, 73 (42 male, 31 female) patients (average age: 70±10yrs) are 2 years postoperative with all patients enrolled in an IRB approved outcomes registry. The tibial component was an allpoly inlay design.

At two year followup, all patients showed significant improvements, compared to pre-operative values, in Knee Society Knee (p<0.0001) and Function (p<0.0001) scores, sf-12 PCS scores (p<0.0001), WOMAC total scores (p<0.0001) and WOMAC pain (p<0.0001), stiffness (p<0.0001) and physical function (p<0.0001) subscores. The tibial components of two patients have been revised to a standard metal backed onlay UKA for loosening.

This initial series of robotically guided UKA implantations provided significant improvement in the post-operative function of patients in every functional measurement with only two revisions to date, likely for improper patient selection. These patients were revised to standard UKA components. The introduction of new procedures and technologies in medicine is routinely fraught with issues associated with learning curves and unanticipated pitfalls. Because the explicit objectives of this novel technology are to optimize surgical procedures to provide more safe and more reliable outcomes, these favorable results provide the potential for significant improvements in orthopedic surgery.
THE ACCURACY OF A ROBOT SYSTEM FOR LESS INVASIVE KNEE ARTHROPLASTY

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ROBODOC is a well known tool for a computer assisted arthroplasty. However, the incision tends to enlarge with the system because of the restriction of range of motion. We have developed the robot system for minimally invasive arthroplasty. This report shows the accuracy of our system composed of original planning software, navigation and bone cutting robot.

We took the DICOM data of cadaver knees from computed tomography. The data were transferred to the workstation for planning. Matching points for registration and cutting planes were determined on the planning software. Cutting tool was the 6th robot which was able to recognize the locations of its apex and the cadaver knee with navigation system. We made five planes for TKA and two planes for UKA on femur. Then we made one plane on tibia. We evaluated the accuracy by measurement the location of cutting plane under navigation system and by CT data.

The registration errors of femur and tibia were less than 1.0mm about cadaver knees. The errors of cutting planes were 1.3 mm about the distal end of femur and 0.5 mm about the proximal end of tibia. The accuracies of the angles of cutting planes were 1.9 degrees and 0.8 degrees compared to the mechanical axis.

The errors of anterior and posterior plane of femur were increased compared to the distal plane. It was because the accuracy of registration were correct in axial direction but was not satisfied in rotational direction. The error was considered by the location of points which decided the rotation alignment. We will make effort to minimize the errors of registration and put it into practical use as soon as possible.
Computer assisted knee arthroplasty systems provide the surgeon with tools for planning the femoral and tibial cuts, automatic implant sizing, and precise guidance for the bone milling and sawing tools. These systems require 3D models of the patient’s proximal tibial epiphysis, and distal femoral epiphysis. Currently preoperative CT scans are used to construct these models. The high irradiation, financial and time cost of the CT motivated the research for an alternative. In this work we developed a system for reconstructing a 3D bone model from a set of points localized by the surgeon intra-operatively on the bone surface using an optical localizer.

A training set of 314 dry femurs, and 314 dry tibias (200 males, and 114 females) of Caucasian ethnicity was CT scanned, and segmented to create 3D models for these bones. These models were then used to extract the modes of variation for the femurs and tibias within each gender. Using these modes of variation along with the average model for the training set, a new femoral or tibial epiphysis model can be reconstructed. This reconstruction is performed by optimizing the average model’s morphology along the modes of variation to create a 3D model that matches the point cloud localized on the surface of the bone.

A set of 77 male and 71 female dry femur and tibia pairs was used to digitize a sparse point cloud on the knee joint using an optical localizer. These point clouds were then used to reconstruct their corresponding models using the aforementioned algorithm. An average error of 0.42 between the reconstructed and the CT models was obtained.
METAL IONS IN CONJUNCTION WITH PATIENT ACTIVITY: HIP RESURFACING PATIENTS AT VARIOUS STAGES OF FOLLOW UP

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Evidence with respect to conventional hip arthroplasties suggests that device wear is related to patient activity rather than duration of usage. Activity level questionnaires appear to suggest that subjects with resurfacing arthroplasties continue to remain active after the procedure. However there is a paucity of objective evidence relating to the step rates of these patients in their daily lives and its effect on metal ions generated. The aim of this investigation is to assess (i) the activity levels of hip resurfacing patients as follow up progresses and (ii) if there is any correlation between activity and metal ions generated.

Twenty-five consecutive male patients (average age 56 years) who underwent a unilateral 50 mm diameter hip resurfacing carried out by a single surgeon (DJWM) were recruited after informed consent. Patient step activity (Step Activity Monitor, SAM, Cymatech. Seattle WA, USA) was recorded at 1, 2, and 4-year follow-up stages and at the same time patient whole blood samples were collected and analysed using High Resolution Inductively Coupled Mass Spectroscopy (HR-ICPMS).

All patients in this study had well functioning hips at the four year follow up stage. All femoral components implanted were within the desired range of neutral to 10°. The mean acetabular component inclination angle was 42° (33° – 55°). Patient overall step activity remains unchanged up to the 4-year follow-up period.

At one year follow up, the whole blood cobalt and chromium concentrations show no correlation to mean number of steps taken per day by each patient (r²=0.02). The correlation between whole blood cobalt and chromium concentration versus a function of body weight and peak index is not significant (r²=0.11).

This study provides objective evidence of the activity rates of patients at different stages of follow-up after a MoM surface replacement arthroplasty. It should be emphasised that the walking speeds of these patients on average was significantly slower than 1 Hz, which is generally used in laboratory hip simulator studies.
LONG-TERM HYDROPHILIC PROPERTIES OF ENGINEERED ZIRCONIA SURFACES FOR ORTHOPAEDIC IMPLANTS
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In recent years, patterned ultra-hydrophilic thin films have received attention because of their potential as biocompatible surfaces for implants. However, mechanical properties of the studied surfaces are not sufficiently robust for the majority of applications. Via an ion-beam assisted deposition process, we have fabricated nanostructurally stabilized, pure cubic zirconia thin films possessing properties of hardness (16 GPa) and wettability, which are expected to benefit tribology and wear reduction. These transparent, zirconia coatings are maximally wettable by water and bovine calf serum, which is explained by the Wenzel model based on the nanotextured surface and surface energy.

The effect of aging on hydrophilic properties of cubic zirconia was determined by water contact angle (CA) measurements on samples stored in a laboratory environment from February of 2005 until now. Measurements for samples without any cleaning showed CA of around 90°, indicating surface adsorption of moisture, organic contaminants, and/or gases over time. A cleaning procedure consisting of sonication in organic solvents followed by calcination at temperatures ranging from 300°C to 600°C was found to effectively burn off residual organic contaminants, yielding CA about 10° to 20°. X-ray diffractometry and atomic force microscopy analysis of these samples revealed that the cleaning procedure induced no apparent changes in the crystal structure and nanotextured surface.

We conclude that the observed loss of ultra-hydrophilic properties was due to organic contaminants. Our results reveal a cleaning method for the long-term maintenance of the wettability of zirconia, making it a viable material for applications involving hard, hydrophilic surfaces, such as biomedical implants.
IN VIVO NORMAL KNEE KINEMATICS: IS ETHNICITY OR GENDER AN INFLUENCING FACTOR?
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Previous in vivo studies have not documented if ethnicity or gender influence knee kinematics for the healthy knee joint. Other measurements, such as hip-knee-ankle alignment have been previously shown to be significantly different between females and males, as well as Japanese and Caucasian populations in the young healthy knee [1]. Differences in knee kinematics in high flexion positions may relate to both etiology of osteoarthritis and success in knee replacement designs. Although differences in knee anatomy have been identified, their significance in knee function has not yet been clarified. Therefore, the objective of this study was to determine the 3D, in vivo normal knee kinematics for various subjects from different gender and ethnic backgrounds, and to identify significant differences, if any, between populations.

The 3D, in vivo, weight bearing normal knee kinematics was determined for 79 healthy subjects, including 48 Caucasians, 24 Japanese, 42 males, and 37 females. Each participant performed deep knee bend activity from a standing (full extension) to squatting to a lunge motion, until maximum knee flexion was reached. The study was approved by the Institutional Review Board and informed consent form was obtained from all subjects. The 3D bone models, created by segmentation from MR images, were used to recreate the 3D knee kinematics using the previously described fluoroscopic and 3D-to-2D registration techniques (Fig. 1) [2,3]. Tibiofemoral rotations were described using the ISB recommended Grood and Suntay convention [4,5]. Anterior-posterior translations of the centers of the posterior femoral condyles were normalized due to significantly different anthropometry in the subjects. Anterior cruciate ligament (ACL) laxity was also measured using a KT-1000 device for 72 of these subjects. Statistical analysis was performed using the Student’s t-test, set at the 95% confidence interval.

Most subjects achieved very high flexion, however substantial variability occurred in all groups. Range of motion (ROM) varied from 117° to 177°, while average external rotation was 31°±9.9° for all subjects. Japanese and female subjects achieved greater ROM than Caucasian (p=0.048) and male (p=0.014) subjects. From full extension to 140° of flexion (which 87% of subjects achieved), few significant differences between any of the populations were observed. At deeper flexion, the external rotation was higher for female than for male subjects, however not statistically significant (p=0.0564 at 155°). Also at deep flexion, the adduction was significantly higher for female subjects. The translations of the lateral condyle were very similar between respective groups, but at deep flexion, the medial condyle remained significantly more anterior for females, leading to greater axial rotation and ROM. As ACL laxity increased, flexion/extension ROM significantly increased (r²=0.184, p<0.001). In addition, ACL laxity was also higher for females (6.8 mm) compared to males (5.6 mm, p=0.011), as well as Japanese (7.5 mm) compared to Caucasian (5.6 mm, p=0.0002) subjects.

High variability and ROM in knee kinematics were similar to those seen in previous studies of healthy subjects during a deep knee bending activity [6]. Subjects in this study achieved much greater axial rotation and ROM than previously analyzed TKA patients. A relationship was found between greater axial rotation and increased ROM, and may be related in part to increased ACL laxity in the knee. Significant differences in ROM and laxity were identified between genders and ethnic groups. Also the medial condyle remaining significantly more anterior for females than for males in deep flexion may explain higher external rotation and consequently higher flexion experienced by women. However, understanding the causes for variability within each group may be the key to improved implant design.
References
RELATIONSHIP BETWEEN THE KINEMATIC FLEXION AXIS OF THE KNEE AND COMMONLY USED ANATOMIC AXES
J David Blaha, David DeBoer, C. Lowry Barnes, Richard Obert, Satya Nambu, Paul Stemniski, Michael Carroll

Introduction: Many attempts have been made to describe the flexion axis of the knee based on landmarks or simple geometric representations of the anatomy. An alternative approach is to use kinematic data to describe the axis of motion of the joint. The helical axis is one kinematic parameter that can accomplish this. The purpose of this study was to compare the correlation between kinematic and anatomic axes of motion.

Methods: Six cadaver lower extremities were skeletonized except for the knee joint. Passive navigation markers were implanted, and CT scans obtained. The limbs were then placed in an open-chain lower extremity rig that allows full range of knee motion. Three-dimensional kinematic data were recorded using a camera and the helical axis of motion was calculated. Anatomic landmarks were placed on CT derived CAD models of the extremities consisting of spherical and cylindrical fits of the femoral condyles and a trans-epicondylar axis. Data for the normal knee was processed, by comparison of the helical axis to the landmark axes over varying ranges of flexion and the variation in helical axis direction within that range was also calculated.

Results: The flexion range with the minimum variation of anatomic parameters to the helical axis was 30-100°. Helical axis variation in this range was $5.489 \pm 1.173$, while variation between the helical axis and those axis defined by spherical, TEA, and cylindrical landmarks were $5.115 \pm 2.129^\circ$, $3.127 \pm 2.029^\circ$, and $5.111 \pm 1.710^\circ$, respectively. A students t-test was performed on each data set with the null hypothesis that the angular difference between the anatomically defined axes and the helical axis is zero. All axes were found to be significantly different from the average helical axis in the range of 30-100° ($P= 0.002$, 0.013, and 0.001, respectively). The tightest variation in the helical axis occurred at 40-50° of flexion $2.89 \pm 0.722$.

Conclusion/Discussion/Summary: None of the anatomic landmarks considered in this study represent a consistently valid approximation of the kinematic flexion axis of the knee. The TEA represents the closest approximation of the three with a 95% CI between 0.998 and 5.256°. The range of 30-100° represented the tightest variation over the largest range of flexion. Extension was defined at approximately 30° based on kinematic profiles of internal/external rotation which show a “screw-home” tendency beginning at 30° through extension. This behavior is consistent with an increase in helical axis variation in ranges that were less than 30° of flexion. In a previous open-chain model, both compartments of the joint were spinning around 45 degrees of flexion, which is consistent with the smallest helical axis variation observed in the 40-50° range.
GAP BALANCING VERSUS MEASURED RESECTION TECHNIQUE FOR TOTAL KNEE ARTHROPLASTY
Running title: Gap Balancing Versus Measured Resection for TKA
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Each author certifies that his or her institution has approved the reporting of these cases, that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained.

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ROBOTICS AND SMART TOOLS IN TOTAL KNEE ARTHROPLASTY
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Surgical instrumentation for total knee arthroplasty has improved the accuracy, reproducibility and reliability of the procedure. In recent years, minimally invasive surgery introduced instrumentation that was reduced in size to fit within the smaller operative field; with this move the impact and influence of technology became proportionately larger. The introduction of computer navigation is an attempt to improve the surgeon’s visibility in a limited operative field, improve the position of the resection guides, and ultimately the position of the final components.

While it may be appealing to rely on computer navigation to perform a TKA, it is not artificial intelligence and does not make any of the surgical decisions. The procedure still is surgeon directed with navigation serving as a tool of confirmation with the potential for improvements in surgical accuracy and reproducibility. The accuracy of TKA has always been dependent upon the surgeon’s judgment, experience, ability to integrate images, utilize pre-operative radiographs, knowledge of anatomic landmarks, knowledge of knee kinematics, and hand eye co-ordination. Recent advances in medical imaging, computer vision and patient specific instrumentation have provided enabling technologies, which in a synergistic manner optimize the accurate performance of the surgery. The successful use of this technology requires that it not replace the surgeon, but support the surgeon with enhanced intra-operative feedback, integration of pre-operative and intra-operative information, and visual dexterity during the procedure. In developing smart tools or robotic systems, the technology must be: safe; accurate; compatible with the operative field in size and shape, as well be able to be sterilized; and must show measurable benefits such as reduced operative time, reduced surgical trauma and improved clinical outcomes. Advocates believe this is attainable and robotic assisted TKA can achieve levels of accuracy, precision and safety not accomplished by computer assisted surgery.

Smart instruments and robotic surgery are helping us take the next step into the operating room of the future. The role of robots in the operating room has the potential to increase as technology improves and appropriate applications are defined. Joint replacement arthroplasty may benefit the most due to the need for high precision in placing instruments, aligning the limb and implanting components. In addition, this technology will reduce the number of instruments needed for the procedure potentially further improving efficiency in the operating room. As technology advances, robots may be commonplace in the surgical theater and potentially transform the way total knee arthroplasty is done in the future. Robotic surgery and smart tools are new innovative technologies and it will remain to be seen if history will look on its development as a profound improvement in surgical technique or a bump on the road to something more important.
Surgical skills and the principles of efficient behavior are often formed very early in a clinical career. They are rarely consciously analyzed or critically evaluated thereafter. Indeed, it is fair to say that more surgeons have videotaped their golf swing than their surgical technique. Operative efficiency is a critical ingredient to surgical success. Efficiency creates speed and speed begets volume. Complication rates are directly related to shortened surgical times and highly efficient operative procedures. The concept of creating “muscle memory” through repetitive task, of eliminating costly gaps in surgical flow, and the willingness to analyze and alter even the most successful practices are the essence of personal improvement. While patterns of behavior in surgical experience vary enormously, the principles of expeditious surgeries include such mundane considerations as consistent staff, a simplified surgical system, extensive preoperative preparation, instruments that suit the surgeon more than the patient, and the innate desire to improve the result with every procedure. While rarely discussed, the concepts of appropriate volumes, outcomes oversight, and cost accountability will undoubtedly define the success of joint centers in the 21st century.
Technological advances and economic trends are shaping the future of orthopaedics, where a clinical solution encompasses all phases of surgery. Minimally invasive surgery (MIS) continues to become more popular and important in modern-day orthopaedics, but brings added complexity to the operating room. Computer assisted surgery (CAS) has the potential to provide greater reliability, repeatability, and control to orthopedic surgeries, although limitations in the technologies currently available for minimally invasive CAS procedures leave much to be desired. Despite new techniques and modern technologies, improvements are needed to achieve consistency of optimal patient outcomes in orthopaedic surgery. Healthcare markets are moving to emphasize the value of patient-specific intervention with reliable, custom solutions.

We are developing a framework for orthopedic CAS which utilizes new technologies and a cohesive approach in providing a robust solution for the future of orthopaedics. Through the use of surgical preplanning, intra-operative guidance, and post-operative gait analysis, a full analysis and design cycle is used to ensure optimal patient outcome by focusing on the combination of the three surgical phases. In order to realize this comprehensive framework, a system-level design approach combined with cutting-edge technology is needed, catering to patient-specific anatomical reconstruction.

In the pre-operative phase, X-ray images are used in the 3-D reconstruction of patient-specific models of the targeted anatomy. This is combined with automated morphometric measurements to provide automatic cutting plane alignment and a complete design suite for patient-specific implants. In the intraoperative phase, new wireless navigation technologies provide robust performance where optical and electromagnetic tracking systems fall short. MEMS capacitive sensor array technology provides accurate and real-time pressure sensing feedback for ligament balancing, and new software frameworks virtualize surgical protocols. Extensive gait analysis including X-ray fluoroscopy provides 3-D kinematic data in the post-operative phase to provide valuable feedback on implant performance for improved implant design.
TRIBOLOGICAL AND MATERIAL ANALYSES OF RETRIEVED ALUMINA AND ZIRCONIA CERAMIC BALL HEADS CORRELATED WITH POLYETHYLENE WEAR AFTER TOTAL HIP REPLACEMENT

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It has been suggested that the wear of ultra-high molecular weight polyethylene (UHMWPE) in total hip replacement is substantially reduced when the femoral head is ceramic rather than metal. However, studies of alumina and zirconia ceramic femoral heads on the penetration of an UHMWPE liner in vivo have given conflicting results.

The purpose of this study was to examine the surface characteristics of 30 alumina and 24 zirconia ceramic femoral heads and to identify any phase transformation in the zirconia heads. We also studied the penetration rate of alumina and zirconia heads into contemporary UHMWPE liners. The alumina heads had been implanted for a mean of 11.3 years (8.1 to 16.2) and zirconia heads for a mean of 9.8 years (7.5 to 15).

The mean surface roughness values of the explanted alumina heads (Ra 40.12 nm and Rpm 578.34 nm) were similar to those for the explanted zirconia heads (Ra 36.21 nm and Rpm 607.34 nm). The mean value of the monoclinic phase of two control zirconia heads was 1% (0.8% to 1.5%) and 1.2% (0.9% to 1.3%), respectively. The mean value of the monoclinic phase of 24 explanted zirconia heads was 7.3% (1% to 26%).

In the alumina group, the mean linear penetration rate of the UMWPE liner was 0.10 mm/yr (0.09 to 0.12) in hips with low Ra and Rpm values (13.22 nm and 85.91 nm, respectively). The mean linear penetration rate of the UHMWPE liner was 0.13 mm/yr (0.07 to 0.23) in hips with high Ra and Rpm values (198.72 nm and 1329 nm, respectively). This difference was significant (p = 0.041).

In the zirconia head group, the mean linear penetration rate of the UHMWPE liner was 0.09 mm/yr (0.07 to 0.14) in hips with low Ra and Rpm values (12.78 nm and 92.99 nm, respectively). The mean linear penetration rate of the UHMWPE liner was 0.12 mm/yr (0.08 to 0.22) in hips with high Ra and Rpm values (199.21 nm and 1381 nm, respectively). This difference was significant (p = 0.039).

The explanted zirconia heads which had a minimal phase transformation had similar surface roughness and a similar penetration rate of UHMWPE liner as the explanted alumina head.
ACOUSTIC EMISSION STUDIES OF PATIENTS WITH PROSTHETIC HIPS AND OSTEOARTHRITIS – A NEW DIAGNOSTIC TECHNIQUE?
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The analysis of hip joint vibrations (phonoarthrography, vibration arthrometry, vibroarthrography, hip auscultation) has been explored as a means to assess joint pathologies, disease status and recently, incipient prosthesis failure. Frequencies <100Hz have been used to diagnose gross pathology and wear in knee prostheses, frequencies from 1k to 10k Hz for progression of osteoarthritis, and frequencies >10k Hz for loosening of cemented hip prostheses. It is possible that detailed analysis of higher frequencies could detect and quantify the smaller geometric changes (asperities) that develop in articular prosthetic wear.

We examined the ultrasound emission generated by various types of hip prostheses and native hips of 98 patients. The ultrasonic transducer was attached to the skin over the greater trochanter with a hypoallergenic, transparent dressing using a standard acoustic coupling gel layer on the microphone face to improve skin contact. The transducer was attached by a 2m cord to a battery operated, data recorder/logger. The patients were asked to sit in a chair, rise, sit again and then rise and take 5 steps while recording the acoustic data from these two movements of sitting and walking. This procedure was repeated for the opposite hip in each patient as well. Acoustic emission analysis examined frequency distributions and power spectrums of the recorded signals and their relations to prosthesis type and implantation time. Review of x-rays of prosthetic and native hips was carried out with OA grading and prosthetic wear quantification.

We have obtained data on 79 metal-polyethylene (average duration of 8.5 years; 0.1-28), 20 ceramic-ceramic (average duration of 8.5 years; 0.5-10), 17 metal-metal (average duration of 1.2 years; 0.1-5.5) and 15 ceramic-polyethylene (average duration of 0.6 years; 0.1-1) hip arthroplasties as well as 75 native hips.

Analysis of the data enabled us to tell the difference between patients whose native hips did not cause them any discomfort and those patients with painful osteoarthritis (initial findings indicate that OA severity can be quantified as well). The measurements of wear of the metal-polyethylene prostheses obtained from patients’ x-rays were compared to an analysis of the ultrasonic emissions, a homogeneity showed no significant differences (all p's > 0.24) between the curve type and amount of wear of the prosthesis polyethylene.

Our data suggests that we are capable of assessing the status of OA by acoustic emission. Further analysis of wear data coupled to ultrasonic emission is needed for accurate quantification of THA wear.
DO RESTING PERIODS INFLUENCE POLYETHYLENE WEAR IN KNEE SIMULATOR STUDIES?
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Knee wear simulator studies are performed to evaluate wear behavior of implants. Simulation of the human gait cycle is often carried out continuously, without considering resting periods as they are part of patient’s daily live. In addition to dynamic activities like walking, daily activities also consist of static periods like standing, sitting or lying. During the day dynamic activities alternate continuously with static periods and most of the day is spent in passive periods, where no joint motion occurs. Such resting periods have not yet been considered in prosthetic knee wear tests. Implementing resting periods may cause an increase in friction and thus increased wear of the implant. The aim of the current study was to determine if the implementation of resting periods would increase polyethylene (PE) wear in total knee replacement (TKR).

Two wear studies were conducted using a force controlled AMTI knee simulator on a conventional bicondylar TKR. For the first study, simulation was carried out continuously according to ISO 14243-1. For the second test, four active gait cycles according to ISO 14243-1 were followed by one resting period cycle. In both tests 5x10E6 active load cycles at a frequency of 1 Hz (resulting in additional 1.25x10E6 pause cycles for the second test) were applied. Wear was measured gravimetrically and wear scars were documented photographically.

The mean wear rates measured 2.85 ± 0.27 mg/10E6 cycles for the ISO test without considering resting periods and 2.27 ± 0.23 mg/10E6 cycles for the test with resting periods implemented. There was no significant difference (p=0.22) in wear rate between both tests. The inserts showed similar wear scars in both tests and no relevant differences in dimension and localization on the surface. Therefore the wear behavior after the two tests was similar.

Since wear is one of the most limiting factors for implant longevity, proper preclinical wear studies are essential. Based on the results of this experimental wear study, a continuous simulation without additional resting periods seems to be valid in wear simulation of TKR.
A monobloc porous tantalum acetabular cup with a 28mm internal diameter was employed in 397 primary total hip replacements between August 1997 and December 2003. All patients were personally examined at yearly intervals for 3 years following surgery and at 2 year intervals thereafter. Thirty-one patients were known to have died and 69 hips were lost to follow up less than three years following implantation, leaving 297 hips (81%) available for review up to 10 years following implantation.

The mean age at surgery was 66.2 years, with 12% of patients aged 80 years or older. 58% of the patients were female and 42% male. 82% of the patients had osteoarthritis. Clinical and radiographic data were analyzed for patients followed for a minimum of 3 years. Mean follow up was 5.4 years. The mean preoperative Harris hip score was 31, increasing to 89 at last follow up.

The most common complication was dislocation. Eleven patients had dislocations in the early postoperative period: 4 required closed and 2 open reduction, and five required revision of the acetabular component for recurrent instability. Three patients (4 hips) with severe rheumatoid arthritis developed late instability and required acetabular revision. Four patients had a femoral fracture, 2 of which healed with slight settling and 1 of which required open reduction, subsequently became infected and required removal of the prosthesis. There was 1 superficial and 2 additional deep infections, one of which required component removal. Two patients had a fracture of the greater trochanter and required internal fixation. Four femoral components loosened, of which 3 were revised, all without involvement of the acetabular component. There were 3 transient sciatic nerve palsies; one resolved completely and two partially, although all 3 were lost to follow before 3 years.

The porous tantalum monobloc acetabular components performed remarkably well at up to ten years following implantation. There were no instances of clinical or radiographic loosening, no osteolysis and no measurable wear visible on postoperative radiographs. The highly porous tantalum achieved reliable bony ingrowth in all cases. We hypothesize that the direct compression molding of the polyethylene into the porous tantalum substrate eliminated the backside wear and the flexion of the polyethylene liner that occurs in modular cups.
EFFECTS OF SURGICAL POSITION ON THE VARIABILITY OF REGISTRATION IN IMAGE-FREE NAVIGATION SYSTEM FOR THA
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In image-free navigation system, three bony landmarks (typically both anterior superior iliac spines (ASIS) and pubic symphysis) are registered intraoperatively by manual palpation. If the registration of bony landmarks is inaccurate, the final orientation of the cup determined by the navigation system will also be inaccurate. We therefore examined intra- and intersurgeon variability in registration and the distance between registration points in each bony landmark with two surgical positions.

Thirty-seven THAs were performed in the lateral position and 15 THAs were performed in the supine position. The cup was fixed using the image-free OrthoPilot hip navigation system (B. Braun Aesculap, Tuttlingen, Germany). The registration was repeated two more times by operator and assistant, and the intra- and intersurgeon variability of cup abduction angle and anteversion was analyzed by ICC (intraclass correlation coefficients). In 25 hips, the distance between intrasurgeon registration points and that between intersurgeon registration points in each landmark were calculated.

The ICC in the lateral position ranged between 0.59 and 0.81, and between 0.85 and 0.95 in the supine position. The ICCs of cup abduction angle for the intra- and intersurgeon variability were 0.92 and 0.95 for the supine position and 0.65 and 0.59 for the lateral position. Those of anteversion were 0.93, 0.85, and 0.81, 0.72, respectively. The variability of registration of collateral and contralateral ASIS in the lateral position was greater than that in the supine position.

In image-free navigation system, the variability of registration points depended on bony landmarks and patient position. The registrations of pubic symphysis in the supine position and all bony landmarks in the lateral decubitus position are standing further improvement.
An artificial articular cartilage is being investigated for use in joint replacement. The low elastic modulus lining on the bearing surface is used to promote a continuous lubricant film between the articulating surfaces and hence reduce both friction and wear.

Polyvinyl formal (PVF) as an artificial articular cartilage was proposed to prolong the service life of joint replacement. The major raw material of the PVF was a polyvinyl alcohol (PVA) hydrogel, which was one of the few polymers with hydrophilic properties. It is anticipated to realize a wide range of clinical applications due to its high water-holding capacity and high biocompatibility. However, a major problem with PVA hydrogel is its low wear resistance. The PVF was made by performing a chemical cross-linking reaction in PVA, and its pore diameter, porosity, and beam density could be controlled by varying the concentrations of cross-linking agent (formaldehyde) and catalyst (sulfuric acid).

The knee joint simulator was used for investigating the wear performance of the PVF. The load and motion cycles were taken from ISO 14243-3. The peak load was 2.6 kN, and the walking cycle was 1.0 seconds. The lower PVF specimen represented the flat tibial component of the joint, and the femoral component was artificial knee joint which made from Co-Cr-Mo alloy. The lubricant was a waterbased liquid containing the principal constituents of synovial fluid.

The PVF survived for more than 1.0 million cycles. Enlargement of the PVF creep deformation by prolongation of simulating time was not obvious. Although the tribological property in fatigue wear produced by ploughing friction was inadequate, it was obvious that the PVF was a potential material for developing a load bearing system with hydration lubrication.
Soft tissue balancing of the “flexion gap” has a direct affect on patello-femoral tracking. Both of which are necessary for a well functioning Total Knee Arthroplasty (TKA). Traditionally, successful restoration of soft tissue balance and patellar tracking depend heavily on surgeon experience, empirical judgment and technical skill.

Orthopaedic residents often are confronted with the challenge of learning to perform TKA without objective measures with which to assess the accuracy of their surgical technique. Also, the vast majority of TKA’s are performed by surgeons who do less than 25 TKA’s per year. Both populations often rely upon surgical release of the lateral patellar retinacular tissues in order to restore “optimal” patellar tracking. This surgical technique is often associated with division of the lateral geniculate vessels and increased potential for avascular necrosis of the patella and lateral subcutaneous hematoma. Both groups of surgeons would be well served if there were available a means with which they could objectively measure whether or not they have in fact achieved the soft tissue balance they intended and optimal patello-femoral tracking, without the need for a lateral release.

Historically, the incidence of lateral release, as a means of improving patellofemoral tracking, has been reported performed in more than 10% of TKA. A prospective group of 200 consecutive TKA’s, performed by two surgeons, in which an electronic means of assessing “flexion gap” balance was retrospectively reviewed for the incidence of intra-operative lateral release. It was found that use of electronic measurement to assure “flexion gap” balance was associated with a significant reduction in the incidence of lateral release required to achieve optimal patello-femoral tracking.
STRATEGY FOR FEMORAL LIFT-UP IN THA THROUGH DIRECT ANTERIOR APPROACH – CADaver STUDY AND CLINICAL EXPERIENCES
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Direct anterior approach (DAA) is an inter-muscular approach that needs no muscle detached. In THA through DAA approach, exposure of the acetabulum is facilitated, while the key points of this approach are femoral lift-up and hip extension to get sufficient access to the femoral canal. To investigate the strategy for femoral lift-up, we released the capsule step by step and measured the distance of femoral lift-up at each step in cadavers and clinical cases. The effects of hip extension on femoral lift-up were also evaluated.

Three fresh frozen cadavers were used. In supine position, the hip joint was exposed through DAA by two experienced surgeons. After anterior capsulotomy and femoral head resection, posterior capsule release was performed followed by superior capsule release in one side, and superior release was followed by posterior release in the other side. Finally, internal obturator muscle was released in both side. At each step, the distance of femoral lift-up was measured under the traction force of 70N. The effects of hip extension were investigated in 0, 15 and 25 degrees hyper-extension. Thirty-six THA were performed through DAA. Posterior capsule release was performed followed by superior capsule release in 13 hips, and superior release was followed by posterior release in 23 hips. At each step, the distance of femoral lift-up was measured under the traction force of 70N at each step same as the cadaver study.

In cadaver study, anterior capsulotomy and posterior capsule release affected little the femoral lift-up. The distance increased after superior capsular release. The distance decreased as hip hyperextension unless the superior capsule was released. The effect of internal obturator muscle release was not observed. In clinical studies, the same tendency was observed in clinical cases. Superior capsule release was the most effective for the femoral lift-up.

The results of this study indicate that superior capsule release is the first step for the femoral lift-up. The second step is hip extension to get access to the femoral canal. By performing these procedures step by step, rasping and stem insertion can be achieved with minimal soft tissue release.
INTRAOPERATIVE DIFFERENCES IN ALIGNMENT, RESECTION HEIGHT, AND COMPONENT SIZING WHEN MEASURED BY COMPUTER NAVIGATION VS. CONVENTIONAL JIG BASED APPROACH

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Introduction: Computer navigation has been shown to improve rotational alignment, angular alignment and sizing, when compared to a conventional jig based approach. These studies have all looked at post operative radiographic evaluation as the indicator. This study measures the intraoperative difference between the conventional jig based approach and the computer navigated system.

Methods: 59 total knee arthroplasties were performed by a single surgeon between September 2006 and February 2007. The author was trained in this technique during fellowship and has performed over 250 CAOS total knee replacements. All knees were DePuy PFC sigma implanted with the DePuy Ci system using Brainlab software. The femoral sizing was performed using the jig after the distal femoral cut had been made using the navigation system. The difference between the size recommended by the jig was recorded. The implant was chosen by the computer recommendation, and the jig was used only for data collection. The tibial jig was then placed in the standard fashion using an extramedullary jig. The navigation marker was then placed into the jig slot, and the varus/valgus, posterior slope, and resection height were recorded using the computer modeling as the reference. The jig was then re-aligned if the computer measured angle was greater than 2 degrees in any plane, or the resection height was greater than 2mm. The cut was made using the computer recommended position if the differences exceeded these parameters. Tibial plate size was obtained using the “best fit” technique even if that differed with the computer recommendation. All post operative x-rays were then evaluated with x-ray and obvious outliers in size or angulation were recorded.

Results: One tibia was too short to be measured with a jig, so the N for tibial data is 58. Average measured difference in varus/valgus was 1.26 degrees with 53 valgus (range 0-3.5) and 5 varus (range 0-3.6). Tibial slope average difference was average 2.31 degrees with 54 posterior (range 0-6.5 degrees) and 4 anterior (range 1-2.5 degrees). Tibial resection height difference was average 3.31mm with 4 measured high (0-3.5mm) and 54 measured low (0-6.9mm). Femoral sizing using the jig correlated with the expected size using CAOS in 28 of 34 (82%) of cases. Tibial size “best fit” correlated with CAOS in 46 of 58 cases (84%). The tibial jig was repositioned in 20 of 58 (35%) cases prior to making the cut. No tibial or femoral re cuts after the original cut were required in any case. Without using specific measurements, all post op x-rays had satisfactory alignment and component sizing, however 2 tibial plates had mild lateral overhang.

Discussion: The data suggest that in most cases, the jig approach is satisfactory, however, the computer prevents outliers. The more preoperative deformity was present, the greater variation between the measurements. The femoral jig in the conventional system we used, does not take into account femoral width, and there is no way to correct for posterior condyle deformity, this is why it is felt that the femoral fit is better with the CAOS system. Femoral rotation would not be able to be measured without using the intramedullary jig, so this step was bypassed, but if femoral rotation followed the other data, the computer would prevent malrotation in some cases. Had the conventional jig been used, the data suggests that at least one patient would have had anterior slope of the tibial tray. One patient had a tibia that was too short
to use the conventional extramedullary jig. Since no intramedullary jig was available on the set, the tibia would have had to be placed freehand if the CAOS system was not available. These data suggest that the CAOS system is preventing erroneous cuts in some cases confirming the data published regarding radiographic evaluations with respect to a decrease in the number of outliers.

References:
EVALUATION OF TKA PERFORMED WITH AND WITHOUT COMPUTERNAVIGATION: A BILATERAL TKA STUDY
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Introduction: Obtaining accurate anatomic and mechanical alignment in total knee arthroplasty (TKA) is correlated with improved long-term results. Whether computer-assisted total knee arthroplasty (CAS-TKA) more reliably produces a neutral mechanical and anatomic alignment and improves functional outcomes over traditional total knee arthroplasty (T-TKA) remains debatable. This report evaluates the results of CAS-TKA vs. T-TKA in a series of patients who underwent bilateral TKA performed at the same surgical operation.

Methods: Sequential bilateral TKA were performed on 36 patients utilizing CAS-TKA in one knee and T-TKA in the contralateral knee by two high volume, fellowship trained surgeons. A review and statistical analysis of prospectively collected data was performed after a mean follow-up of 2.2 years.

Results: Knee Society Scores (KSS) improved from 42.9 to 96.3 in the CASTKA group vs. 46.0 to 94.8 in the T-TKA group. Range of motion (ROM) improved from 116.8° to 126.9° in the CAS-TKA group vs. 118.3° to 125.4° in the T-TKA group. With numbers available, there were no differences between the groups with regard to change in KSS (p=0.38), ROM (p=0.42), mean postoperative anatomic alignment (5.78° vs. 5.50°, p=0.37), femoral angle (5.56° vs. 5.61°, p=0.84), or tibial angle (89.89° vs. 89.69°, p=0.46). There was a non-significant trend towards fewer outliers in the CASTKA group with respect to anatomic alignment (2.8% vs. 13.9%, p=0.09) and tibial angle (0% vs. 5.6%, p=0.46).

Conclusion: There is not an apparent benefit to the use of CAS-TKA with regards to KSS, ROM, or alignment in the hands of high-volume, fellowship-trained total joint specialists. The clinical relevance of the non-significant trend towards fewer outliers in the CAS-TKA group is unknown at the current follow-up interval. These results may not preclude the benefits of CAS-TKA in lower-volume or less experienced TKA surgeons.
TOTAL KNEE ARTHROPLASTY IN SKELETAL DYSPLASIA
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Introduction: Total knee arthroplasty (TKA) in patients with skeletal dysplasia is challenging due to the anatomic variances and deformities. The purpose of this review is to understand the technical issues involved in treating these patients.

Methods: Clinical notes, operative reports, and radiographs were retrospectively reviewed of 12 knees in 8 patients: 3 achondroplasia patients (one with bilateral 10° varus deformities, one with a 30° varus deformity in one knee and 25° varus deformity in the other knee, one with a 14° varus deformity); 3 multiple hereditary exostosis patients (one with bilateral 45° valgus deformities, one with a 45° valgus deformity in one knee and 15° valgus deformity in the other, one with a 11° valgus deformity); and 2 osteogenesis imperfecta patients (one with a 25° varus deformity, one with a 17° valgus deformity).

Results: Surgical exposure required preoperative placement of soft-tissue expanders to avoid wound complications (1 knee), quadriceps snip (2 knees), and hardware removal (1 knee). Intraoperative balancing of the knee was more complex requiring a lateral epicondylar osteotomy (3 knees), medial release (6 knees), lateral retinacular release (6 knees), and proximal realignment to improve patellar tracking (1 knee). 5 knees required a constrained insert, 2 required tibial augments, one required use of cement and screw technique, and one required modification of an all-polyethylene tibia to accommodate the deformed tibial anatomy. 2 knees required custom tibial components. Complications included 2 peroneal nerve palsies which resolved 3 months postoperatively. Range of motion preoperatively averaged 103° (range 45 to 130°) and 100° postoperatively (range 85 to 120°). All patients were pain-free at their last followup (average follow-up 3.9 years).

Conclusion: Special considerations must be made regarding surgical exposure, ligament balancing, implant selection, and anticipation of complications due to the unusual deformities when performing TKA in skeletal dysplasia patients.
COUNTERACTING MATERIAL RELIABILITY PROBLEMS IN HIP PROSTHESSES BY MEANS OF ADVANCED METHODS OF RAMAN SPECTROSCOPY

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Total hip arthroplasty (THA) represents a very spread and effective surgical procedure. Surgeons and technologists make daily efforts in improving the outcomes of THA, with the ultimate goal of creating a prosthesis that reliably lasts at least as long as a human lifetime. While the results of primary hip arthroplasty are generally very good, revision surgeries might score variable success with regards to their clinical outcomes. In addition, they invariably represent an expensive procedure and a severe burden to the patients. Thus, a reduction of the failure rates of only a few percents can, due to the large number of patients involved, have a vast influence on the accumulated costs and patient suffering. In other words, the key issue in hip arthroplasty resides in the improvement of the prostheses with regard to their long-term in vivo reliability. These circumstances amply justify a continuous search for new hip prostheses with improved structural characteristics and elongated lifetimes.

Most recent innovative trends in THA have focused on the improvement of the tribological behavior of hip joints and challenged the achievement of a longer durability, with the potential for a service-life spanning several decades. Such trends have naturally led to an increase in the use of ceramic materials, either as ceramic femoral heads yet coupled with advanced acetabular cups made of polyethylene (i.e., with improved molecular structure and quality), or as ceramic hip components for both acetabular and femoral bearing surfaces. The greater driving force in using ceramic bearings is their potential of systematically reducing periprosthetic osteolysis (i.e., mainly arising from polyethylene wear debris), which could potentially reduce the number of surgical revisions. The high inertness and biocompatibility of ceramic materials may also reduce to a minimum the collateral effects on the human body, as possibly observed with metallic prostheses (e.g., contamination by metal ions, hypersensitivity, etc.). Despite those advantages, chipping and fracturing have severely limited the popularity of ceramic components. As a further issue, it should be noted that ceramic-on-ceramic articulations strongly require high precision in setting the orientation of the components during surgery (in order to avoid excessive impingement on the ceramic surface). Partly fractured ceramic bearings necessarily dictate revision. The main reason is that the ceramic remnants in the articulation would give rise to severe third-body wear, especially in the presence of a softer bearing counterpart. Clearly, ceramic components offer a very high potential for further improving both structural performance and lifetime of hip joints but, being made of fragile materials, they also require significant progress in surgery technique, further advancements in joint design and materials manufacturing processes, as well as a peer non-destructive control of their structural reliability.

In this presentation, we shall first have a brief survey on the main cases of failure in the recent history of hip prostheses. Then, a description of the most advanced and recent technological approaches to material preparation, reliability control and non-destructive analysis of hip components will also be given. The main aim of this presentation is to drive the attention of the international orthopaedic community on the need for a highly interdisciplinary approach to the study of hip joint arthroplasty. In this context, we provide here some vivid examples of how newly developed Raman spectroscopic methods may provide final solutions to historical problems related to the chemical and structural reliability of materials widely employed in total hip arthroplasty.
BIONIC DESIGN ON JOINT PROSTHESSES OF LOW FRICTION AND LOW WEAR WITH HYDROGEL ARTIFICIAL CARTILAGE
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The reduction of both friction and wear is required in existing joint prostheses composed of ultra-high molecular weight polyethylene (UHMWPE) and metallic or ceramic components, or even in Hard-on-Hard joint prostheses. In contrast, the healthy natural synovial joints with rubbing surfaces of articular cartilage are likely to operate at very low friction and low wear for the entire lifetime in the adaptive multimode lubrication mechanism, in which various lubrication modes become effective in various daily activities. Therefore, to establish a similar lubrication mechanism in joint prostheses by the application of compliant artificial cartilage, we conduct various researches to improve lubrication modes resulting in reduction in both friction and wear. In this paper, the effectiveness of the hydrogel artificial cartilage of high water content is discussed from the viewpoint of bionic design to mimic natural synovial joints.

The aim of this paper is to facilitate a function based on multimode lubrication mechanism in joint prostheses similar to natural synovial joints. Firstly, the possibility of full elastohydrodynamic lubrication was evaluated by experimental methods in friction tester and joint simulator. The joint prostheses with compliant rubbing materials or polymer-on-hard joint with better geometrical congruity showed significant fluid film formation, but some local intimate contact occurred. Therefore, as the second viewpoint, the effectiveness of adsorbed film formation was examined. The noteworthy phenomena are remarkable reduction in friction for artificial joint with poly(vinyl alcohol) (PVA) hydrogel articular surfaces and a notable increase in friction for artificial joint with polyurethane surface in hyaluronate solutions containing serum proteins. These results indicated that adsorbed protein films can reduce or increase friction and wear depending on probably fluid film thickness. Other findings of effectiveness of layered adsorbed film and negative effect of heterogeneous adsorbed film are described on the basis of various observation in friction tests.

As the third viewpoint, the importance of biphasic lubrication and hydration lubrication for hydrogel surface with high water content is discussed. In friction tests of natural articular cartilage against glass plate, it was observed that the unloading for 5 min after continuous 30 min rubbing reduced the friction at restarting probably due to biphasic lubrication and/or hydration lubrication after rehydration, where adsorbed films have some influences on friction and wear. For joint prostheses with compliant hydrogel artificial cartilage, similar mechanism is required for surface and bulk structure of artificial cartilage.

In this paper, several important essential points from the bionic design are indicated for development of the next generation for joint prostheses with higher function and better longevity.
BIOMECHANICAL ANALYSIS OF POSTERIOR CRUCIATE LIGAMENT RETAINING HIGHFLEXION TOTAL KNEE ARTHROPLASTY
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Introduction

High-flexion knee replacements have been developed to accommodate a large range of motion (ROM > 120°) after total knee arthroplasty (TKA). Femoral rollback or posterior translation of the femoral condyles during knee flexion is essential to maximise ROM and to avoid bone-implant impingement during deep knee flexion. The posterior cruciate ligament (PCL) has been described as the main contributor to femoral rollback. In posterior-stabilised TKA designs the PCL is substituted by a post-cam mechanism. The main objective of this study was to analyse the mechanical interaction between the PCL and a high-flexion cruciate-retaining knee replacement during deep knee flexion. For this purpose, the mechanical performance of the high-flexion cruciate-retaining TKA design was evaluated and compared with two control designs including a high-flexion posterior-stabilised design.

Materials & methods: Prosthetic knee kinematics and kinetics were computed using a three-dimensional dynamic finite element (FE) model of the knee joint. The FE knee model consisted of a distal femur, a proximal tibia and fibula, a quadriceps and patella tendon, a non-resurfaced patella, TKA components and a posterior cruciate ligament in case cruciate-retaining designs were evaluated. Tibio-femoral and patello-femoral contact were defined in the FE knee model and the polyethylene insert was modelled as a non-linear elastic-plastic material. Three different rotating platform TKA systems were analysed in this study: the high-flexion cruciate-retaining PFC Sigma CR150, the high-flexion posterior-stabilised PFC Sigma RP-F and the conventional cruciate-retaining PFC Sigma RP (Depuy, J&J, UK). Both the polyethylene stress characteristics and the tibio-femoral contact locations were evaluated during a squatting movement (ROM = 50° – 150°).

Results: During deep knee flexion (ROM > 120°), the high-flexion cruciate-retaining TKA design showed a lower peak contact stress (74.7 MPa) than the conventional cruciate-retaining design (96.5 MPa). The posterior-stabilized high-flexion TKA design demonstrated the lowest peak contact stress at the condylar contact interface (54.2 MPa), although the post was loaded higher (77.4 MPa). All three TKA designs produced femoral rollback in the normal flexion range (ROM ≤ 120°), whereas the cruciate-retaining designs showed a paradoxical anterior movement of the femoral condyles during high-flexion.

Discussion: PCL retention is a challenging surgical aim and affects the prosthetic knee load and kinematics as shown in this study. In addition, for adequate functioning the PCL should not be too tight or too lax after surgery. Hence, we investigated the effect of PCL laxity on the prosthetic performance and the best-balanced PCL was used in our simulations. Although PCL balancing is not an issue for posterior-stabilized TKA, we found the tibial post to be loaded relatively high for this implant type.
APPLICATION OF NON-DESTRUCTIVE EVALUATION TECHNIQUES FOR THE ASSESSMENT OF BONE CEMENT MICROCRACKING DURING FATIGUE
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Orthopaedic implants are often fixed into place using bone cement. The degradation of the cement mantle has been implicated as playing a major role in the loosening of these implants, and this often necessitates revision surgery. The present work has used the non-destructive acoustic emission (AE) technique to monitor the initiation and evolution of fatigue damage in bone cement constructs. Using this technique, it should be possible to gain an understanding of failure progression in cemented orthopaedic devices. Previous work in this area has focused on AE activity originating from the eventual failure location in order to identify those signatures associated with critical fatigue cracks. This usually involves analysing AE signatures associated with the final stages of failure; however, there have been limited investigations that have looked at the damage that takes up most of the crack propagation life of the sample, (i.e. microcracking formation and development), that occurs away from the failure site, but could still play a role in final failure.

In this study, dog-bone-shaped specimens of bone cement were subjected to uniaxial tensile fatigue loading, with damage monitored along the length of specimens using AE. Where specimens exhibited AE activity at locations away from the fracture site, they were sectioned and subjected to synchrotron tomography, which enabled high resolution images of these regions to be obtained. Microcracks of the order of 20 microns were observed in areas where AE had identified early, non-critical damage; in contrast, no microcracking was observed in areas that either remained unloaded or exhibited no AE. To further corroborate these observations, and characterise the damage mechanisms involved, scanning electron microscopy (SEM) was applied to the sectioned samples. In those locations where significant yet non-critical AE occurred, there was evidence of crack-bridging, suggesting that crack closure mechanisms may have slowed down or even arrested crack propagation within the bone cement.

These findings further validate the use of AE as a passive non-destructive method for the identification and understanding of damage evolution in cemented orthopaedic devices.
TECHNOLOGY FOR COMPARING MANUAL DEXTERITY BETWEEN DIFFERENT ORTHOPAEDIC RESIDENTS
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Formal surgical skill assessment and critical path analysis are not widely used in orthopaedic surgical training due to the lack of technology for objective quantification, reliability, and the discrimination insensitivity of existing methods. Current surgical skill assessment methods also require additional instrumentation, cost and time. Such problems can be overcome by a novel method that records the motion of surgical instrumentation for the purposes of documentation, surgical-skill assessment, and safety analysis. This method uses an existing computer-aided-orthopedic-surgery (CAOS) navigation system and does not compromise its functions of real-time tracking, rendering, or simulation. The stored data allows realistic playback in 3D of the complete bone cutting/refining process. This concept and its sensitivity were previously tested and validated using a robotic arm as a reliable actuator for a surgical instrument moving in controlled paths. In this study, the system was used to evaluate the surgical skills of actual orthopaedic residents in a hospital/lab setting.

Two chief orthopaedic surgery residents participated in the experiment. Each one cut all five distal cuts on four synthetic (right) femurs to accommodate the same femoral implant using NoMiss, an in-house built system for Navigated Freehand bone cutting. The motion of the surgical saw was recorded in real time by NoMiss during the whole procedure, but the real purpose of the experiment (and the recording) was not revealed to the residents until the end of all tests. Based on the data recorded by the navigation system, the following parameters were analyzed: cutting time, area-of-the-cut/time ratio, trajectory of the saw, errors in distance off the plane as well as errors in roll and pitch angles.

While no significant difference among the two subjects was found in bone cutting time (mean 531s vs. 642s, p=0.099), subject 1 (S1) was faster than subject 2 (S2) in total time, which included cutting, reshaping of the bone, and implantation (mean 719s vs. 958 s, p=0.035). Area-of-the-cut /time ratio revealed higher (not significant) proficiency for S1 compared to S2 (mean 16 mm^2/s vs. 13 mm^2/s, p=0.084). Nevertheless considering individual cuts, there was significant difference in the posterior chamfer cut (mean 9 vs. 5 mm^2/s, p=0.015). The analysis of the trajectory of the saw showed less conservative motion (and less consistency) for S1 than for S2 (average total length of trajectory 8.6m (sd=2.1m) vs. 8.1m (sd=0.4m), as well as larger paths in between cuts (average 39% vs. 33% of the total trajectory).

The system/method was able to characterize different subjects without additional instrumentation, cost, time, awareness of or distraction to the user. Slightly better performance was detected for S1 compared to S2 presumably signifying superior skills. The main differences in this case appeared in the cutting of the chamfers, which might be considered the trickiest of the distal cuts in a navigated freehand cutting environment. A larger number of subjects with a wide level of expertise should be analyzed under similar conditions to establish quantitative acceptance limits (e.g. numerical determination for pass/fail criteria).
SMART-SAW FOR NAVIGATED FREEHAND BONE CUTTING FOR TKR: PUTTING FULL CONTROL OF THE CAOS SYSTEM IN THE HANDS OF THE SURGEON

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Computer aided orthopaedic surgery (CAOS) systems aim to improve surgeons’ consistency and outcomes by providing additional information and graphics, often displayed on one or more computer screens. Experience has shown that surgeons often feel uncomfortable looking away from the patient to focus on the computer screen, and multiple methods have attempted to address this (e.g. by using head mounted and semi-transparent displays). We present a new approach, with a small touch-screen wirelessly controlled from the main CAOS computer and micro-controlled electronics all mounted on the cutting instrument and placed along the surgeon’s line of sight from the instrument to the wound. In addition, the micro-controlled system improves the patient’s safety by controlling the cutting speed of the blade (or stopping it), based on the saw’s positioning deviations from the planned cuts. The (on board the saw) computer-user interface also transmits commands to the main computer, based on commands issued on the touch screen.

The “smart” navigated saw was built by integrating a microcontroller, optical trackers, a small 4x6cm viewable touch-screen, and a surgical oscillating saw. Bidirectional wireless communication was established between the saw and a Navigated Freehand Cutting (NFC) CAOS system allowing dynamic speed control of the blade, slowing it down for smaller errors in position/alignment (relative to planned cuts), and stopping it for bigger errors and/or risk of tissue damage. The sensitivity of the correction and width of the allowed error envelope were made adjustable to cater for the individual surgeon preferences. The touch-screen on the saw provided the surgeon with a visual aid for cutting without them having to look away while simultaneously providing control of the interface settings by touch. After electronic bench tests, two orthopaedic residents prepared eight synthetic distal femurs with the NFC system and the prototype saw to accept a commonly used TKR implant.

All parts were integrated into a usable stand-alone device, with no software, hardware, or logical failure registered during the tests. The speed control responded to the established threshold errors and the preferred dynamically adjustable settings were found to be 0.5mm to 10mm of error in location and 0.5° to 10° in pitch or roll angle. The surgeons were satisfied with the user-interface for graphical guidance and system control. No significant difference in implant alignment, fit and cutting time were found compared with the standard NFC system with standard size computer monitors.

By a wireless link between a CAOS system computer and the cutting instrument (with a graphical touch display screen on board), the patient’s safety and surgeon’s visibility needs were addressed allowing the screen to be aligned with the wound. With a user interface on the saw, and automatic speed and stopping control of the cutting instrument based on navigation, the surgeon is prevented from cutting in the wrong place. This surgeon-actuated but “software cutting jig” fulfils the same functions of cumbersome autonomous or passive surgical robots with their sophisticated servo and haptic interfaces, but with startling utility bringing in the era of the modern “smart” hand-held bone cutting instruments.
Computer aided orthopaedic surgical (CAOS) technology has been around for over 20 years, and while it appears to provide better outcomes compared to conventional jigs, less than 1% of orthopaedic surgeons in USA have adopted it. This study surveyed the arguments against CAOS usage, highlighting those reasons which may continue to prevent CAOS from becoming truly widely accepted.

The survey has identified several concerns with navigation systems. For example, the pin tracts from navigation reference frames cause stress risers that increase the risk of bone fracture and soft tissue/muscle damage. Additionally, infrared trackers take footprint space (as they require line of sight access to the tracking camera), increase risk of infection, and present a potential distraction to the surgical team. With current CAOS systems, even more instrumentation is needed than with non-navigated surgical systems, and it is arguable that navigation makes surgery more complex, requiring a knowledge of anatomic landmarks, an increased number of tasks prior to and during surgery, and an assortment of different and perhaps unfamiliar instruments. These complexities very likely result in a slow learning curve on current CAOS systems, a learning curve that is mostly not started by the majority of surgeons.

Other items of concern are the accuracy of morphed/generated bones in imageless systems (and how these models assume non-deformed anatomy), inaccuracies or distortion of the measurements (operating room lighting interfering with infrared trackers or field deformation of electromagnetic systems due to ferromagnetic instruments at the surgical site) and computer reliability. Considering the high cost (or low cost-effectiveness) of integrating CAOS into arthroplasty, and the lack of enough studies documenting truly better long term clinical results or fewer actual complications, it is evident why navigation is not yet a popular option for TKR.

As a result of the critical findings from this study, it is our view that any successful new technique/tool in surgery should make the overall procedure easier, faster, cheaper and better (or at least equally as good) as the current techniques. While robotic surgery seems to be re-emerging, we hypothesize that the next real breakthrough will come from newer more utilitarian light weight small foot print technologies actuated by surgeons themselves, with enhanced computer guidance that will allow them to reduce instrumentation, complexity, and surgical time such as navigated freehand bone cutting. Alternative navigation technologies (e.g. UWB 3D positioning radar) where line of sight becomes less crucial, image based systems (rather than image free), artificial vision, and smart instrumentation are likely to play a major role in achieving widespread future acceptance of CAOS in TKR.
A NEW METHOD FOR OBTAINING IN VIVO FLUOROSCOPIC ARTHROPLASTY EVALUATIONS WITH NORMAL PATIENT MOVEMENT

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Conventional fluoroscopes are routinely used to analyze human skeletal joints during motions such as deep knee bends. Such diagnostics are used to characterize pre and post operative arthroplasty results, particularly in association with total joint replacement procedures. The pseudo-stationary conditions imposed by the fixed fluoroscope limit the diagnostic procedures to much less than natural skeletal motion and load conditions, thus diminishing the 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 essentially a mobile robot that can acquire real-time x-ray records of hip, knee, or ankle joint motion while the patient walks normally within a laboratory floor area. It is anticipated that the TFS will provide clearer and more representative x-ray images.

The robotic mechanization includes an untethered and omni-directional mobile platform that follows the patient as he/she walks, including negotiating stairs or ramps. In addition to following the patient, additional control devices track the joint motions that occur relative to the patient’s body, e.g., knee joint vertical and anterior/posterior relative motion. The technical features of the TFS will be described, and test results related to the commissioning of the TFS for clinical trials will be presented. Initial clinical test results will be provided.
Post-operative stability in a primary TKA procedure requires surgical skill in establishing symmetric flexion and extension spaces. Many surgeons further utilise techniques associated with “gap balancing” by attending to the dimensional space between the femur and tibia in developing flexion and extension gaps following bone resections and/or soft tissue releases. Questions still arise related to these gaps, in particular whether or not these gaps should be created dimensionally equal to each other by adjusting bone resections. Previous publications on this subject point to the conclusion that they are not dimensionally the same, but have a relationship to the supporting soft tissue in the flexion and extension positions. This study has been designed to investigate this premise.

A soft tissue force sensing device, enabling the surgeon to create accurate balanced posterior femoral condylar resections relative to the soft tissues and the proximal tibia, has been integrated into the current surgical technique to create reliable flexion gap symmetry. To extend the concept of using balanced relative force readings to a more complete gap balancing technique, a preliminary distal femoral resection is made to facilitate mounting the adjustable instrument interfacing with the force sensor. Femoral rotation is adjusted to establish a symmetric flexion space based on balancing the relative force values in the two femoral-tibial joint compartments. This sensor guided balancing step establishes the desired tibial insert thickness in the reconstructed knee. The final distal femoral bone resection is then made to equate the extension gap to the balanced flexion gap.

Taking the concept of balanced resection to the next level, special angled inserts have been developed to fit onto the sensor and fill the extension space, in efforts to determine and create a balanced extension space.

Data was gathered to relate the relative flexion force value to the resulting relative extension force value to see how this compares in a series of TKA’s.

The results of this data will begin to shed light on the supporting soft tissue conditions when a true balanced resection technique is utilised. The focus of this study is to evaluate the extension forces resulting from this technique to better define a functional relationship between the flexion and extension gaps in the gap balancing technique.
One of the main reconstructive objectives in a primary TKA is to develop a well balanced knee by focusing on establishing flexion symmetry during the procedure using external femoral rotation. Current surgical techniques rely on anatomic or “boney” landmarks, including the posterior condylar axis, AP axis and Transepicondylar axis (TEA), to accomplish this objective. Variability in using these anatomic references has been sighted in published studies on the subject and clinical complications associated with joint instability continue to surface in the literature. A main reason for this variability is the fact that functional ligament and soft tissue support is not interpreted early enough in the procedure when using anatomic landmarks. This can make correcting flexion symmetry challenging later in the procedure given soft tissue releases vary in their end result. To address this issue, an electronic force sensing technology has been used to balance the flexion space for the past 24 months. This simple reproducible technology utilises a soft tissue force sensing device to develop flexion symmetry by creating balanced external femoral rotation relative to the proximal tibial resection. The sensor and adjustable femoral trial-like device enable balancing the relative forces in the medial and lateral femoral-tibial compartments in the knee to establish symmetry in flexion before the implant trials are placed. This step is performed early in the procedure before the posterior femoral condyles are resected, a technique delivering reliable results covering a broad range of deformities. Since the sensor relies on relative force values cued from the medial pillar, the question of “how tight is just right” needs to be answered to further optimise outcomes. The current study involves 50 posterior stabilised rotating platform primary knees. Data on operative variables was collected and tibial spacers of different thicknesses (matching implant system thicknesses) were introduced into the balanced flexion space to register relative force values. The thickest tibial spacer creating balanced function and ROM was recorded first and the next thinner spacer recorded for comparison. Oxford Knee scores were then collected at two weeks, six weeks and three months following the primary knee reconstruction and associated to the relative force value of the tibial insert implanted to develop functional feedback on “how tight is just right.”

Early experience seems to indicate the tighter tibial insert is the better choice based on the characteristics of the knee design used in this study.

The results of this study have shed important light on tibial insert selection related to functional outcomes. Expanded study on this subject would greatly benefit future surgeons and patients alike.
NEW BACTERICIDAL ALLOGENEIC BONE CONSTRUCTS OFFER CLEAR ADVANTAGES OVER ELUTION TECHNOLOGIES
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Running Title: Modified, anti-bacterial bone grafts

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Infection poses one of the greatest medical challenges, one further complicated by bacterial biofilm formation that renders the infection antibiotic insensitive. The goal of this investigation was to covalently link the antibiotic vancomycin (VAN) to a bone allograft so as to render the tissue inhospitable to bacterial colonization and the subsequent establishment of infection. We could achieve uniform tethering of the antibiotic to the allograft with minimal disruption of the underlying bone structure. The tethered VAN remained active against gram-positive organisms with no detectable S.aureus colonization. Additionally, the grafted VAN prevented biofilm formation, even in protected topographical niches. Attachment of the antibiotic to the allograft surface was robust- the stabilized VAN remained active for long time periods. Osteoblasts cultured on the VAN-allograft evidenced no changes in cellular phenotype. We opine that this new chimeric construct represents a superior transplantable substrate with a plethora of applications in medicine, dentistry and surgery.
CONFIRMATION OF SOFT TISSUE BALANCE IN PRIMARY TKA’S FOLLOWING THE USE OF A SOFT TISSUE FORCE SENSING DEVICE TO DEVELOP BALANCED POSTERIOR FEMORAL RESECTIONS RELATIVE TO THE TIBIA IN-VIVO

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The ability to reliably balance a total knee replacement during surgery eliminates a number of postoperative issues often leading to recurrent joint pain and lower than expected clinical outcomes. Over the past few years a surgical instrument has been available to surgeons performing primary TKA’s to enhance their surgical ability to develop flexion space balance by customizing femoral rotation by developing equal relative forces in the medial and lateral femoral-tibial compartments instead of using rotational anatomic landmarks. Since this concept deviates from the current practice of using anatomic or “boney” landmarks, as in the TEA or AP axis to develop a balanced flexion space with femoral rotation, this study design evaluated the variation in femoral rotation between the force balanced rotation and the conventional external rotation developed from the TEA and AP axes. Using the premise from previous studies that; clinical instability presents itself when the flexion space is asymmetric by more than three degrees, data was analyzed on 50 total knee patients to establish the rotational difference between the force balanced rotation and the rotation using the two conventional axes. Computer navigation was used as the measuring tool in this study.

The study results showed that flexion space asymmetry would have been greater than the targeted three degrees in 38% of the knees in the study when utilising conventional anatomic reference based femoral rotation. The force balanced rotation created additional external rotation from a half to three degrees in these knees, improving patellar tracking.

Based on previous work evaluating laxity in total knee patients, the reliability offered by force sensing technology appears to improve the surgeon’s operative ability to balance a reconstructed knee within three degrees of symmetry in flexion. This new technique appears to improve reported postoperative complications associated with instability in a reconstructed total knee. Further studies utilizing CT scan data to validate the actual femoral rotation and clinical outcome studies are warranted to examine this potential improvement to clinical outcomes in primary TKA’s.
A1005

IMPACT FACTOR IN TISSUE TENSION OF EXTENSION AND FLEXION GAP BALANCE IN COMPUTER ASSISTED NAVIGATION TOTAL KNEE REPLACEMENT (CAN TKR)
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CAN TKR is aimed to improve accuracy in realignment with balanced knee joint. Variability in the force exerted during tissue tensioning depends on the viscoelastic nature of soft tissues.

Aim: To measure gap balance to assess effectiveness of CAN on ligament balance using gap balancing approach with tibia 1st cut.

Methods: OrthoPilot system with 4.3 software and Statistical evaluation with Testimate Version 6.0, IDV Gaunting Germany with a two sided Wilcoxon-Pratt test (P<0.05) used simulating errors in extension and flexion gap balance. P1, control with 16 datasets created and P2-P7 (96 case series) was propagated with ±3mm variants in extension and flexion gap both medial and lateral, only varying 1, keeping others constant. Controls fixed: distal transverse plane cut at 0° to femoral mechanical axis in frontal plane and 3° external rotation in sagittal plane. Tibia cut 90° to mechanical axis. Mechanical axis constant at 0° and gap balance at 0 mm. Deviations in gap errors using trigonometrical calculations based on E-Motion femoral implant, size/thickness; 3/7mm and 4/8.5mm with variation of insert size 10/12mm equal to sum of gap and bone cut.

Results: Over tensioning (OT) distal lateral extension gap (DLEG) causes tight distal medial extension gap (DMEG). Under tensioning (UT) DLEG causes loose posterior medial flexion gap (PMFG). UT DLEG causes tight DLEG. Impact factor >2mm increased PMFG with lateral lift off with only PMFG as variant. Increasing PMFG >2mm caused lax PMFG. UT even by 1mm PMFG causes error by notching and tight PMFG. A considerable number of errors observed in frontal plane of femur. Relationships between OT/UT analyzed by Spearman rank ratio p<0.001.

Conclusions: Change of tissue spreader tension in EG or FG causes improper registration with mismatch in EG/FG/Bone cut. This study provides a baseline to further assess and develop the concept of optimal soft tissue balance as ligaments function properly only with the desired isometry in gap balancing technique.
RELATIONSHIP BETWEEN INTERCONDYLAR OSTEOPHYTES AND CRUCIATE LIGAMENTS IN OSTEOARTHRITIC KNEE
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Newer prosthetic total knee arthroplasty (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 between cross sections of the intercondylar notch and the macroscopic condition of ACL degeneration. Thirty 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 notch images obtained from preoperative tunnel view. 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: 9 cases, Frayed: 9 cases, Partial rupture: 9 cases, and Absent: 3 cases. The macroscopic PCL conditions were Normal: 24 cases, Frayed: 3 cases, Partial rupture: 3 cases, and Absent: 0 case. Occupation rate of the osteophytes to the notch correlated to the preoperative femorotibial angle (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 showed either partial rupture or absent of the ACL during the surgery.

We conclude that occupation rate of the osteophytes to the notch is a good predictor of evaluating the ACL degeneration in osteoarthritic knee.
EFFECT OF SURGICAL APPROACH ON GAIT FOLLOWING TOTAL KNEE ARTHROPLASTY
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Total knee arthroplasty (TKA) is a common surgery to relieve knee pain and increase range of motion due to osteoarthritis (OA) in older patients. Minimally invasive, computer navigated techniques are gaining popularity for knee replacement surgery. These techniques may have potential to provide better functional outcomes over a shorter period of time. Little data exists comparing the early functional recovery of patients following total knee replacement surgery performed using various common approaches. This study compares the functional gait of patients two months after surgery performed using one of four common approaches to determine if differences exist in the immediate recovery. This knowledge will aid surgeons determine the best approach to use when performing surgery.

This study was approved by the appropriate Institutional Review Board. Subjects volunteered to participate in the study and signed informed consent prior to testing. Subjects were excluded if the had significant diseases of the other joints of the lower extremity or a diagnosed disorder with gait disturbance. Patients were randomly assigned to receive unilateral primary TKA using standard parapatellar, mini-parapatellar, mini-midvastus, or mini-subvastus approaches. All patients received the same preoperative, perioperative, and postoperative critical pathways and standard orders. All incisions were five inches and all patients and examiners blinded to type of approach. Surgery was performed by one of two fellowship trained orthopedic surgeons. Patients visited the gait laboratory two months after receiving TKA. Motion data was captured using a ten-camera motion capture system (Motion Analysis Corp., Santa Rosa, CA). Three-dimensional force data was recorded using four floor embedded force platforms (AMTI Inc., Watertown, MA). Patients were asked to walk at a self selected speed along a 6.5 metre walkway. A minimum of five good foot strikes for each limb were recorded. 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). Statistical analysis was performed using SPSS 14.0 software (SPSS Inc., Chicago, Il) (α = 0.05).

Fifty-two patients (72 ± 6 years) volunteered to participate in the study. The approaches used were: standard parapatellar – 12; mini-parapatellar – 12; mini-midvastus – 14; mini-subvastus – 14. Statistical analysis found no significant differences in any of the variables measured except minimum knee flexion angle during stance (p=.046). The variables measured included the maximum and minimum injured lower limb joint angles in all planes during both stance and swing phase of gait. Also measured were the maximum joint moments in all planes during stance and hip, knee, and ankle powers.

Patients who received TKA using the mini-subvastus approach had greater knee extension through much of the single stance phase of the gait cycle which contributed to a lower (but not significant) peak knee flexion moment. These patients also had the highest ground reaction shear forces with higher ankle power absorption at foot strike and generation at push off. Mini-subvastus patients used a higher cadence to walk with a greater velocity then patients who received surgery using the other approaches.

The results of this study show only minor differences in gait between patients who have received surgery using the different approaches. The limited numbers of patients in the study and the large variation in outcomes so soon after surgery mean that in most cases the differences that were measured do not reach significant level. This study shows that the surgical approach used to implant the device has no apparent effect on the ability of the person to ambulate following surgery, however further study with increased numbers of patients and observation over a longer period of time will allow a stronger conclusion. The knowledge gained from this and future studies will enable surgeons to make decisions on type of approach based on factors other than expectations of functional outcome.

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DOES REGISTRY DATA ACCURATELY PREDICT THE FUTURE SUCCESS OF INDIVIDUAL DESIGNS OF JOINT PROSTHESES?

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Joint Registries are a valuable resource for defining the survivorship of prostheses and procedures undertaken for the treatment of joint disease. However, the use of this data as a basis for advocating specific implant designs is controversial because of the confounding effects of variations in patient selection, the training, skill and experience of surgeons, and the priorities of individual patients. Despite these challenges, the Australian Joint Registry has utilized its early survivorship data to identify specific designs that are expected to exhibit lower than average durability in the long term. The aim of this study was to assess the accuracy of this practice in identifying implants providing inferior long-term performance.

Over the period 2004-8, the Australian Registry identified 48 prosthetic components used in primary THA, HRA, TKA or UKA which exhibited a statistically significant increase in the early revision rate. For each of these components, we compared the rate of revisions per 100 “component-years” when it was first identified by the Registry, to its ultimate five-year cumulative survival in 2008. These survival parameters were also compared to average values based on procedure (eg. THR) and fixation method (i.e. cemented, cementless, hybrid). Regression analysis was performed to determine the accuracy of initial relative revisions per 100 OCY as a predictive measure of eventual component revision rate.

Five year survival data was available on 30 of the 48 implants identified by the registry. There was a strong correlation (R²=0.9614) between initial revisions per 100 component-years and the 5-yr survival of the identified designs. 29 of 30 designs (97%) exhibited lower than average survivorship at 5 years. Six designs (20%) had failure rates within 2% of average values, and 7 (23%) had a 5-year failure rate less than 50% above average values. Although, when identified by the Registry, 80% of identified components exceeded the average rate of revision by 100%, only 60% displayed more than twice the cumulative revision rate at 5 years post-op.

These results demonstrate that early data collected by Joint Registries can form the basis of accurate identification of designs which ultimately prove to be clinically unsuccessful. Predictions made by the Australian Registry concerning inferior designs have an accuracy of approximately 80%. Further work is recommended to enhance the valuable potential of Registry data in predicting the outcome of both implants and procedures.
RADIOLOGIC ASSESSMENT OF THE SHORT HIP STEM USING A NOVEL SCORING SYSTEM
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Background: The purpose of this study was to assess the stability of short hip stem postoperatively using the radiographic parameters and a novel scoring system based on the unique fixation mechanism of the short hip stem system.

Materials and Methods: Postoperative radiographic analysis was done for 31 total hip arthroplasties performed using Metha® short hip stem prosthesis. The Metha® short hip stem system (B. Braun Aesculap; Tuttingen, Germany) design provides a unique fixation mechanism, with support at the medial calcar region, lateral neck, and dorso-lateral cortical contact distally. Additionally the modular design offers increased options and variations. We assessed the stability of stem by using a novel scoring system conceptually based on the unique fixation characteristics of the short stem design and included surgeon controlled variables like position and sitting of stem, dorso-lateral cortical contact and filling ratio of stem. The system also incorporated unmodifiable patient specific variables that ultimately render additional stability to the cementless stems in long run.

Results: The positioning of stem was within normal range in all cases in terms of anteroposterior and lateral CCD angles and horizontal offset. The mean filling ratio of stem were 93.48%±4.38% (range 82-100%). 82.75% hips had acceptable sitting of the short stem at the osteotomy site at proximal end of femur. None of the hips showed any amount of subsidence, except one with a static first follow-up subsidence of 2mm. Using our scoring system all hips showed good to excellent results, with mean score of 44.29±3.83 (range 38-50, maximum score 50).

Conclusion: Our scoring system acts as valuable tool for radiological assessment of Metha® short stem post-operatively. Furthermore, in future longer follow-up studies are required to correlate the scoring system with the longevity and stability of the endoprosthesis.
Total knee arthroplasty in last years has changing the field of applications: from old patients with low demand activities is shifting toward younger patients with higher level of activities demand. Details are promising to more reliable outcomes. Surgeons in conjunction with orthopaedic industries are studying a new instrumentation to better fit the anatomy in M.I.S. surgery and more precise design able to reproduce the correct tensioning of ligaments. In the years, two philosophies were developing to the assess femoral rotation in total knee arthroplasty: bone references and ligament references.

The first one use the bone landmarks to assess the right femoral rotation while the second one use the ligament tensioning to assess the femoral rotation. Both technique and instruments are able to attend good outcomes, further anatomic and biomechanical studies seem to show that the difference between the two surgical approach can be avoided. Instead of developing a new class of instruments, we put together the two philosophies giving to the surgeon more challenge to assess the femoral rotation in total knee arthroplasty. This study shows the early results with FBI instrumentation (Zimmer ins, Warsaw). We operated 24 patients using FBI instrumentation. The case load included 16 men and 8 women. The age distribution was from 63 to 75 years with a median age of 68. The operation time has been the same one of the traditional instrumentation.

So far the patients have been shown good and improved early recovery. There was not any complication during the early post-operative time.

This is use a mini soft tissue tenser good to fit in MIS surgery and a IM rod for the free femoral rotation, at same time surgeon can check the femoral landmarks (Whiteside line and epiline) to put the two ways in conjunction and fitting better outcomes.
LEARNING CURVE IN MINIMALLY INVASIVE TOTAL KNEE ARTHROPLASTY AS MEASURED BY POST-OPERATIVE COMPLICATION RATE
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Minimally invasive total knee arthroplasty is purported to have a number of patient benefits: reduced post-operative pain, earlier mobilisation, and shorter in-patient stay. However, previous literature has identified the existence of a learning curve that may render the procedure unsuitable for low-volume arthroplasty surgeons.

Via retrospective analysis, we set out to compare the incidence of major and minor complications during the first eighty-four minimally invasive total-knee replacements (NexGen; Zimmer UK) undertaken by a single high-volume arthroplasty surgeon starting in April 2004.

The eighty-four patients were sub-divided into four chronological groups (twenty one patients each, designated A, B, C & D respectively). Fifty-three patient records were available for analysis. These comprised: Group A (n=17), Group B (n=13), Group C (n=10), and Group D (n=13), with a mean follow-up of 21 months. Three patients had rheumatoid arthritis, whilst the remaining fifty had osteoarthritis.

There were two major and five minor complications in Group A, one major complication in Group B, one major and one minor complication in Group C, and two minor complications in Group D. Employing a Turkey post hoc ANOVA test, no significant differences were found between the groups when comparing overall complications, or when comparing minor and major complications as separate entities (PASW Statistics 17 for Windows, Chicago, Illinois).

To conclude, although a higher complication rate was observed in this group of patients during the first twenty minimally invasive total knee arthroplasties, this difference was not statistically significant. A follow-up study will analyse the postoperative results of a more recent cohort of patients.
MINIMAL INCISION ACL SUBSTITUTING TOTAL KNEE REPLACEMENT IN YOUNGER PATIENTS
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We performed 112 primary total knee replacements in patients under the age of 50, using a unique implant designed to pivot laterally during range of motion. This design more closely approximates the motion of an ACL deficient knee and controls for the anterior translation typical of more traditional designs. Patients were followed prospectively for a minimum of 3 years (range, 36 to 54 months) All patients were rated both clinically and radiographically using Knee Society Scores, SF-36 and standard radiographic instruments. Patients also completed a validated questionnaire that examined activity level, functional outcomes and ability to return to sports. Patients were compared to case matched historical controls that received a traditional, medially pivoting or flat on flat knee design.

The senior author performed all procedures using a minimally invasive technique with preservation of the quad tendon and accomplished without lateral release. Inclusion criteria were patients under 50 with documented, tricompartmental osteoarthritis. All patients received the same posterior cruciate retaining, laterally pivoting knee prosthesis. Implanted with cement. All patients had resurfacing of the patella performed. The patients were compared to a case matched group of patients that received a modern medially pivoting knee replacement design.

At last follow up, the mean Knee Society functional score was 94. There were no infections, fractures or other major complications in this group. Patients reported quicker recovery of quadriceps function, return to walking without assistance and quicker return to vigorous sports such as tennis. Functional outcomes were statistically improved over historical controls. There was no loss of radiographic alignment or increased signs of loosening compared with historical standards on the most recent radiographs.

Total knee arthroplasty using a ACL substituting device was functionally superior to medially pivoting devices in this patient population. Patients reported better quadriceps dependent activities such as stair climbing and getting up from a chair. They were able to participate in more active sports without late signs of loosening or osteolysis. The authors can recommend this design in younger patients interested in vigorous activity, but full evaluation of this prosthesis will require longer-term results.
A1141

PREDICTING SHORT TERM OUTCOME OF PRIMARY TOTAL HIP ARTHROPLASTY: A PROSPECTIVE MULTIVARIATE REGRESSION ANALYSIS OF 12 INDEPENDENT FACTORS
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Not all patients receive enhanced mobility and return to comfortable, independent living after Total Hip Arthroplasty (THA). It would be beneficial to both surgeons and patients to be able to predict short term outcomes for THA. The purpose of this study was to investigate factors affecting the short term outcome of primary THA and develop a multivariate regression model that can predict such outcomes.

This was a prospective study of 101 patients, who underwent primary THA. All patients were followed for a minimum of 1 year. 12 independent variables, including age, gender, diagnosis, presence of preoperative comorbidities, BMI, preoperative WOMAC physical component (PC) score, type of anesthesia, type of fixation, surgical time, estimated blood loss, use of a postoperative drain, and length of stay were analyzed using correlation and multivariate regression analyses. Multivariate regression models were validated using an independent cohort.

Correlation analyses showed three variables significantly influence short term THA outcome. These include preoperative WOMAC PC score (PC) (p< 0.01), gender (G) (p= 0.01) and the presence of preoperative comorbidities (CMB) (p= 0.02). By multivariate regression analysis, the following regression model was obtained:

\[ \text{Outcome} = \text{PC} \times 0.45 - G \times 9 + \text{CMB} \times 8 + 62. \]

This model exhibited positive correlation (R2=.25) when compared to a separate cohort of 27 patients undergoing THA not included in the original equation derivation.

Our multivariate regression analysis has yielded statistical, multivariate confirmation or non-confirmation of common, predictive THA factors that have previously been reported in the literature. This study provides a concrete, statistically significant measure indicating that preoperative WOMAC PC score, gender, and the presence of preoperative comorbidities are predictive factors for short term primary THA outcome. Finally, our multivariate regression equation can be used to predict the general short term patient outcome following primary THA.
IN VIVO ASSESSMENT OF 3D KINEMATICS AND SOUND OF THE KNEE JOINT FOR SUBJECTS WITH VARIOUS ARTICULAR CARTILAGE CONDITIONS.
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Previously, Komistek et al have demonstrated anomalous behaviours in total joints such as separation (sliding) in THAs and condylar lift-off in TKAs. These cases result in reduced contact area, increased contact pressure, polyethylene wear and could induce prosthetic loosening and joint instability. However, here is no known research done on correlating kinematic conditions with acoustic data for the tibio-femoral joint interface. This study deals with the development of a new method to diagnose such conditions using sound and frequency data. The objective of this study was to determine and compare the in vivo, 3D kinematics and sound for younger subjects with a normal knee, to those of older subjects, with an un-implanted and implanted knee joint.

Ten older subjects having a Hi-Flex PS MB TKA and a contralateral non implanted knee and five younger subjects (with a normal knee) were analysed under in vivo, weight-bearing conditions using video fluoroscopy and a sound sensor while performing four different activities. (1) deep knee bend to maximum flexion (2) gait (3) stair climb and (4) chair rise and sit. Three piezoelectric tri-axial accelerometers were attached to the femoral epicondyle, tibial tuberocity and the patella respectively. The sensor detects frequencies that are propagated through the tibio-femoral interaction. The signal from the accelerometers was then transferred to a signal conditioner for signal amplification. A data acquisition system was then connected to receive the amplified signal from the signal conditioner and transfer it to a laptop for storage. A sampling rate of 10500Hz was used and frequencies upto 5000Hz were recorded. The signal was then converted to audible sound. Also, 3D tibio-femoral kinematics of the knee was determined, for the four activities with the help of a previously published 2D-to-3D registration technique. The fluoroscopy video and the sensor measurements were synchronized, analysed and compared from full extension to maximum knee flexion for DKB, one full cycle of gait, one complete step on stair climb and from sit-to-stand positions in chair rise.

On average the subjects achieved more flexion with their TKA than with their contralateral knee and consequently experienced significantly higher ROM for their implanted knee. However, both of these groups achieved lower ROM than the normal knees. Significant differences were seen in the AP position of the tibiofemoral contact point. The contact point of the medial condyle for the TKA knee was significantly more posterior at 0° and 30° and remained more posterior than the same condyle of the contralateral throughout flexion. Posterior femoral rollback was seen in all groups, with the normal knee achieving significantly higher posterior femoral rollback when compared to the contralateral and TKA knees. Audible signals were observed for all three groups of knees. The frequency analysis revealed that specific frequencies for all groups were within the same range, but the most dominant frequency for each varied. This may be related to the variable interaction surfaces leading to different dominant frequencies which were excited at magnitudes related to the type and condition of material being impacted (polyethylene/meniscus).

This was the first study to correlate in vivo kinematics to in vivo sounds in the knee. The sounds that were detected correlated well to in vivo motions, especially abnormal kinematic patterns. The ultimate aim of this study is to create a stand alone tool (based only on sound data) that could be used as a diagnostic tool to determine total joint conditions and reduce the dependence on radiation techniques.
A NEW TECHNIQUE FOR CORRECTING VARUS DEFORMITY AND FLEXION CONTRACTURE DURING TOTAL KNEE ARTHROPLASTY: THE “INSIDE-OUT” TECHNIQUE
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INTRODUCTION: In 1979, our senior author described his technique for correcting a flexion contracture during total knee arthroplasty (TKA) by additional resection of the distal femur and posterior capsular release; he also described his method of correction of a varus deformity by raising a subperiosteal sleeve from the proximal tibia. Due to concerns related to elevation of the joint line as well as flexion/extension gap asymmetry and instability, our technique has evolved into a methodical soft tissue release at the level of the joint line. Our hypothesis is that this technique effectively corrects both deformities, while reducing the complications related to the more traditional techniques. The purpose of this study is to describe this technique and assess its effectiveness in a series of 31 consecutive patients.

TECHNIQUE: Highlights of this technique are as follows: 1. This method involves osseous resections of 10mm from the level of the uninvolved surfaces of the femur and tibia in order to restore the mechanical axis. 2. A transverse release of the contracted posterior capsule is performed with electrocautery at the level of the tibial resection from the posterior margin of the superficial medial collateral ligament (MCL) to the posterolateral corner of the tibia. 3. A controlled lengthening of the superficial MCL is achieved by pie-crusting.

RESULTS: Over a 12 month span, we have corrected these biplanar deformities in 31 knees without residual instability. There were no residual flexion contractures greater than 5 degrees. The maximum varus corrected was 30 degrees, and the maximum flexion contracture corrected was 20 degrees. The mean coronal plane correction was to 5.5 degrees of valgus (range: 1 to 9 degrees).

DISCUSSION: In a series of 31 consecutive patients, this technique was effective in correcting both deformities. We achieved a mean range of motion of 115 degrees, while avoiding elevation of the joint line or instability. Theoretically, this method should result in more optimal knee mechanics than traditional methods. While we are reporting good early results, a prospective, randomized controlled study is needed to better evaluate this technique.
THE REVERSE SHOULDER PROSTHESIS FOR GLENOHUMERAL ARTHRITIS ASSOCIATED WITH SEVERE ROTATOR CUFF DEFICIENCY: CLINICAL AND RADIOLOGICAL RESULTS OF A NEW ECCENTRIC GLENOSPHERE

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Purpose: The purpose of this retrospective studies is to evaluate the real effectiveness, with clinical and radiologic evaluation, of the eccentric glenosphere and also how a correct position can prevent the scapular notching.

Material and Methods: We implanted in 18 patients, with eccentric arthropathy, a 36 mm eccentric glenoshere. 24 months' clinical and radiographic follow up. All patient were assessed preoperatively and postoperatively with the Constant Score. In the post-operative radiographic control we have taken in consideration: the presence of notching, psna (prosthesis-scapular neck angle), pgrd (peg glenoid distance), glenoid inclination, craniocaudal position of the glenosphere in relation to the glenoid.

Results: The ROM increased in all level. All of the 18 shoulder had no notching. The craniocaudal position of the glenosphere in relation to the glenoid is 4.3 mm. The PSNA was 92° and the PGRD was 21.2.

Conclusion: The inferior scapular notching is the most important complication of reverse prosthesis. The results of our study indicate that: the correct positioning of the metal back, at the center of the glenoid (better biomechanics stability), without overhang and with eccentric glenosphere, permits to lower the center of rotation of 4 mm avoiding the notch and so increasing the adduction and abduction range of motion.
Musculoskeletal models of the lower limb lend insight into muscle forces and joint mechanics during dynamic activities. However, traditional musculoskeletal modeling is based on rigid body assumptions, and frequently represents the knee as a hinge joint, neglecting the complex interactions between the patella, femur, and tibia. Implementation of the musculoskeletal modeling framework in an explicit finite element environment allows joint contact to be easily incorporated, as well as representation of any structure as rigid or fully deformable in order to evaluate, for example, implant stresses or bone strain. Prediction of these values is particularly valuable when evaluating implant mechanics after total knee replacement.

A finite element, musculoskeletal model of an implanted right lower limb was constructed, including thirteen muscles crossing the knee joint. A Hill-type muscle model was developed to allow muscle activation within the explicit FE framework. Muscle forces were predicted by optimization of muscle activation patterns during flexion-extension and chair-rise activities. The effect of muscle path representation was investigated using two approaches: lines of action directly between the origin and insertion sites of the muscles, and lines of action along the centroid of the muscle bodies. Incorporating anatomic muscle paths into the model reduced the predicted peak quadriceps force during the chair-rise activity by 46%, and reduced the peak tibio-femoral contact pressure by 14%. In addition, bone strain was predicted during the activity for the implanted patella, and showed peak bone strain at the edge of the implant near the inferior pole.

The muscle-activated models demonstrated the advantages of an explicit finite element framework, and allow rapid, rigid body simulation in addition to the full contact, deformable analyses when greater resolution is required.
A1186

RE-THINKING CRUCIATE RETENTION IN TOTAL KNEE ARTHROPLASTY: INTRODUCTION OF A NEW TECHNIQUE FOR FUNCTIONAL POSTERIOR CRUCIATE RETENTION IN TKA

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We introduce a new technique called the “Posterior Cruciate Referencing Technique” (PCRT), a specific combination of surgical technique, devices and instrumentation. Careful anatomic preservation of the posterior cruciate ligament (PCL) based upon a specific reference point off the tibia allows for use of sloped tibial components to achieve consistent functional behavior of the PCL. We discuss the preclinical design and development leading to availability of this device, and subsequent early clinical experience with this approach.

Posterior cruciate ligament (PCL) retention in total knee arthroplasty (CR-TKA) has been a feature of certain styles of TKA since the inception of predictable TKA in the early 1970s. It has been adapted and promoted as advantageous for a number of real and theoretical benefits. In reality, however, PCL retention has proven inconsistent when applied across a broad range of surgical environments. A number of adaptations in surgical technique, device modification and instrumentation have been developed to try to improve the predictability of the surgical intervention and subsequent postoperative performance. It is our belief that currently recommended surgical techniques can lead to inconsistencies in surgical judgment and consequently performance of CR devices because they inadvertently compromise the anatomy and hence functional performance of the PCL. A study by Shannon et al showed that, during CR-TKA, the PCL was either partially or completely removed as a result of the tibial cut in two out of three cases [1]. Unlike the long held and validated approach of ligament release for fixed New Technique for Functional Posterior Cruciate Retention in TKA varus and valgus deformity that, along with alignment, allow successful long 45 term outcomes, ligament release of the PCL to balance the knee in flexion, whether by bone cuts or physical release, may compromise its overall function and explain kinematic differences in expected versus observed performance. Our hypothesis is that devices, surgical techniques and instruments designed around anatomical and functional preservation of the PCL would promote a reproducible surgical approach and consistent clinical performance of a CR-TKA. This manuscript provides the rationale for development of a new technique called the “Posterior Cruciate Referencing Technique” (PCRT), a combination of technique, instruments and devices specifically designed to preserve the PCL anatomy and take advantage of the functional performance of the PCL. We discuss the anatomical, radiographic, kinematic and mechanical testing approach that suggests that this is a safe and effective approach for primary CR-TKA.

Conclusion: This manuscript presents a body of work that elucidates specific issues of implant design and technical implantation that may have led to inadvertent compromise of function of the PCL during CR-TKA. We believe that such compromises may explain the inconsistent kinematic behavior of these devices in the hands of surgeons who use them, and may result in clinical outcomes that were unintended. We have provided the rationale for a new technique of implantation - the Posterior-Cruciate Referencing Technique (PCRT) - which mates specific referencing approaches of the PCL and tibial resection, with implants, to address PCL functional New Technique for Functional Posterior Cruciate Retention in TKA behavior. We have provided laboratory, pre-clinical and early clinical evaluations that suggest that this will prove a safe and effective approach to CR-TKA.
ANALYSIS OF NORMAL AND REPLACED KNEE KINEMATICS IN AN ISOMETRIC EXTENSION MODEL
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Introduction: An open-chain model was used to investigate the kinematics during isometric extension between normal knees and knees replaced with a tricompartmental prosthesis.

Methods: Ten cadaver legs were skeletonized while preserving the knee joint capsule, quadriceps and hamstring tendons. CT scans of the extremity were converted to CAD models that precisely related the bone surfaces to radio-opaque motion analysis markers. The limbs were mounted in a custom open-chain extremity rig [1]. Tibial motion was produced by a linear actuator attached to the quadriceps tendon in the direction of the vector addition of the absent quadriceps muscles. Tendon force was measured with an in-line force transducer and recorded at 300 Hz during the motion. Three-dimensional kinematic data of the isometric extension motion of the knee were recorded at 30 Hz using a motion capture camera system and combined with CAD models of the extremity to evaluate joint kinematics through virtual animations, contact points, and kinematic profiles. After collecting data on normal knee kinematics, each specimen underwent total knee replacement with commercially available implants. Anatomic and implant coordinates were registered to the motion capture data and the captured motion was imposed on the virtual model. The femoral anatomic axis was defined as a line from the center of the femoral head to the posterior cruciate ligament (PCL) femoral insertion point [2]. The tibial anatomic axis was defined as a line from the center of the line connecting the proximal tibial prominences to the center of the distal tibial articular surface [2]. The femoral internal/external (IE) rotation reference was a line connecting the peaks of the medial and lateral epicondyles [2]. The tibial IE rotation reference was a line defined by the anterior boundaries of the articular surfaces [3]. IE rotation angle was defined as the angle between these two reference lines, on a plane perpendicular to the tibial axis. Contact points between the femur and tibia, or corresponding components for the implanted knee, were determined in 30° increments between full extension and 120° flexion [4]. Animations of the virtual CAD models were created for visualization of the motion data.

Results: Tibio-femoral contact points for the normal knee indicate stable behavior on the medial compartment and progressive posterior motion of contact on the lateral side with increasing flexion. The normal knees demonstrated anterior contact on both the medial and lateral sides at full extension (0°). Within the first 30° of flexion, the contact point moves backwards on both medial and lateral sides of the joint, but markedly more so on the lateral. From then on, the contact point stays stable in the mid portion of the medial tibial plateau and more posterior on the lateral demonstrating medial pivoting kinematics. The replaced knee does not demonstrate the “screw-home” from 0°-30° but does demonstrate a stable medial contact point in the mid portion of the tibial plateau and gradual posterior movement of the contact point on the lateral side through 120°, indicating medial pivoting kinematics similar to the normal. These patterns were virtually identical across all specimens. Contact point translation data after knee replacement was consistent with the behavior of the normal knee. The anterior-posterior translation of each condyle for each specimen was normalized and averaged. The replaced knee demonstrated equal or smaller displacement values in all but one category (lateral deep flexion) and maintained similar profiles in all flexion ranges. These results indicate that the replaced knee...
is stable medially throughout the range of motion with controlled lateral translation. The contact point AP position was compared at discreet flexion angles between normal and replaced knees. On the medial side, from 0°-110°, there was no statistical significant difference between the two cases with the p-values ranging from 0.45 to 0.79. However at 115° of flexion, the p-value was 0.04 indicating a statistical difference between the normal and replaced knees. The lateral condylar comparison yielded three flexion angles with a statistical difference, 60°, 105°, and 115° with p-value of 0.05, 0.03, and 0.01 respectively. The mobility of the normal lateral compartment and the more constrained motion path of the replaced component are a factor of these differences.

Kinematic profiles of internal-external rotation and adduction-abduction for normal knees were consistent in shape among all specimens. Replaced knee kinematic profiles varied from normal but were consistent across specimens. The peak quadriceps tendon load for all specimens occurred at 65° with a decrease as the leg progressed to full extension. Tendon load of the implanted knee reached a maximum at 65° which then remained nearly constant through 15°. Tendon loads at 65° are within 10% of the normal knee loads (-4.5% ± 5.6) with two of the three specimens having greater than 10% decreases in tendon load.

**Discussion and Conclusion:** The normal knee kinematics appear to be driven by the bone geometry and the physical constraints of the soft tissues. The replaced knee kinematics are dependent mostly on the designed geometry of the implants since both cruciate ligaments and cartilage are absent from these trials. The total knee prosthesis implanted was designed as a ball-in-socket on the medial side with a “ball-in-arcuate groove” on the lateral side. This design was intended to mimic the stable medial side of the normal knee while allowing the lateral side to rotate around it. In this open chain model, both normal and replaced knees indicate a stable medial side and free motion on the lateral side, demonstrating medial pivoting kinematics. The replaced knees also closely approximate the surface kinematics of the normal knees. Variation in kinematic profiles between the normal and replaced knees are partially attributed to surgical alignment correction. The quadriceps load necessary to move the knee at the same rate through the same range of motion were similar for the replaced knee compared to the normal knee exceeding the normal load by a maximum of 2%.

**References**
TKA: CHANGING PATIENTS AND DEMOGRAPHICS: IMPLICATIONS FOR FUTURE IMPLANT NEEDS
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It has become a platitude that total knee arthroplasty (TKA) is an excellent operation, provides good pain relief, and over 90% survivorship at 20 years in many series. While all these points are true, total knee arthroplasty as practiced currently still will not meet the demands of many patients who will desire the procedure in the next ten years. The reasons for this include changing demographics of TKA and the changing demands of TKA candidates. TKA is being performed more frequently in patients under 60, in fact this is the fastest growing group of patients by percent growth. We performed a population-based study of trends utilization of TKA and found increasing TKA utilization in all age groups over time but the greatest increase by percent in the youngest patients. Furthermore, younger patients now no longer tend to be low activity patients with inflammatory disease. The percentage of patients with primary osteoarthritis and post traumatic arthritis has increased dramatically. Long-term studies of TKA have shown such durability in part because many of the youngest patients were Charnley Class C patients, and because historically most TKA patients were older with an average age of most early series of around 69 years. This means there were far fewer young patients in early TKA series than in early THA series. This is important because material failures occur predominantly in younger patients and durability is a greater concern in younger patients, so one may predict that this younger, more active group will not enjoy the same level of TKA durability reported in the literature unless technology improves.

Total knee arthroplasty patients are more active than one might predict. In a study of 1200 patients surveyed at five years the average UCLA score was 7 out of 10. Younger patients achieved a higher activity level but were in general less satisfied with activity provided by TKA than older patients. This implies there is a need for better designs and surgery to facilitate more normal kinematics, more flexion, and more quadriceps strength. A study by Weiss and Noble (CORR 2002) identified specific activities associated with limitations after knee arthroplasty. Furthermore, a study by Bourne and associates demonstrated lower satisfaction scores after total knee arthroplasty than hip arthroplasty. Finally, in our study of activity levels after knee arthroplasty we found that 16% of current patients participate in heavy labor or sports not recommended by Knee Society guidelines. These patients tend to be younger and predominantly male. This implies there is a subset of the population already doing things that will challenge the current generation of total knee arthroplasty and more patients want to do these activities and already do so. Therefore, there is a need for improved implant durability and improved knee function after knee arthroplasty. This suggests the methods of fixation may need to evolve to accommodate higher demands, and bearing surfaces definitely need to evolve to accommodate higher demands. Finally, more sophisticated implant kinematics to avoid or compensate for anterior cruciate ligament and posterior collateral ligament deficiency and more sophisticated surgery to optimize implant alignment and soft tissue balancing in the individual patient will be necessary to achieve more normal patient knee kinematic stability, strength and “feel”. Finally, we will need better and more sensitive scoring systems to detect improvements in future TKA surgery and design in the future.
HOW TO OBTAIN SOFT TISSUE BALANCING IN TKA
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Soft tissue balancing remains the most subjective and most artistic of current techniques in total knee arthroplasty. It is well known that it is more difficult to achieve posterior roll-back with CR than with PS. Extension and flexion gaps on the sagittal plane, and medial and lateral gaps on the coronal plane have to be well balanced. However, it is very difficult to match these four. Biomechanical properties of the soft tissue were obtained during the surgery, using the specially designed system. The system consists of two electric load cells in the tensioning device, digital output indicators, and an XY plotter. Load displacement curves were obtained in extension and in flexion. Interestingly, the stiffness of curves obtained from the lateral in flexion is 1/3 lower than the other three. However, it is very questionable whether we can adjust these materials precisely and constantly or not.

To achieve posterior roll-back and deep knee flexion, ligament balancing is more important in cruciate retaining TKA than in PS Knee. Posterior impingement and anterior lift-off are often seen during surgery. That means “too tight in flexion”. First of all, elementary correction of the coronal deformity is performed by appropriate removal of osteophytes and soft tissue release. A pre-cut is made 2-3 mm distal to the conventional cutting line at the distal femoral end. Femoral component size is determined in accordance with the antero-posterior dimension. Posterior femoral condylar resection is performed. A load is applied in flexion to measure flexion gap. The extension gap is then measured in extension with the same load as that which was applied in flexion. Additional bone re-cut of the femoral distal end is performed.

The technique is very similar to the classic flexion-extension gap balance technique. However, the most different point I would like to emphasize is that an accurate and constant load is applied to make both the flexion and extension gaps equal. There is no need to release the PCL using this technique. Therefore, I would like to name this technique “Load dependent gap technique” to emphasize that an accurate and constant load can be clearly applied to equalize the gaps.

In future, using this technique, it could be possible to know what percentage of the load applied in extension should be appropriate in flexion when the two gaps are equalized in TKA.
INTRA-OPERATIVE REGISTRATION OF THE KNEE KINEMATICS BY A NAVIGATION SYSTEM.
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Navigation systems have proved to improve the accuracy of the bone resection during total knee replacement (TKR). They might also be helpful to assess intra-operatively the knee kinematics before and after prosthesis implantation.

We are using the OrthoPilot ® system (Aesculap, Tuttlingen, FRG) on a routine basis for TKR. The current standard version of the software helps the surgeon orienting the bone resections and allows measuring the ligamentous balancing. This version was modified to allow a continuous tracking of the 3D tibio-femoral movement during passive knee flexion and extension. The kinematics was assessed by measuring the tibial movement in these three planes with the femur as reference.

For the purpose of the study, following data were registered before and after implanting the prosthesis: flexion-extension angle, varus-valgus angle, rotational angle, antero-posterior translation. Additionally, the gap between the contact point of the femoral component and the corresponding point of the tibial resection was measured after prosthesis implantation. Two successive registrations were performed by each of the 100 patients of the study before and after prosthesis implantation. The pre- and post-implantation kinematic curves were respectively compared by each patient to assess reproducibility. The pre- and postimplantation kinematic curves were compared by each patient to assess the modification due to prosthesis implantation. The results were compared to the current available literature.

The kinematic curves were plotted from maximal extension to maximal flexion. The observed 3D kinematics seem to be in agreement with the current literature in both in-vitro and in-vivo studies. We could observe the tibial internal rotation and the femoral roll-back during flexion. Some patients experienced paradoxical movement, both before and after implantation. However the post-implantation kinematics was generally closer to the expected one than the pre-implantation kinematics.

The software has definitely the potential to assess the intra-operative knee kinematics during various surgical procedures. It might help to try several solutions (orientation of the resections, implant combination or design, ligamentous balancing…) before final implantation, in order to choose the best individual compromise. The actual relevance of such a study remains to be defined. It might be interesting to compare these data with in-vivo kinematic studies by the same patients.
TRANSPOSITION OSTETOMY OF THE ACETABULUM FOR ADVANCED STAGE OSTEOARTHRITIS OF THE HIPS DUE TO ACETABULAR DYSPLASIA.
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Transposition osteotomy of the acetabulum (TOA) was the first periacetabular osteotomy for the osteoarthritis hips due to acetabular dysplasia, in which the acetabulum was transposed with articular cartilage. TOA improves coverage of the femoral head to restore congruity and stability, and also prevent further osteoarthritis deterioration and induce regeneration of the joint. Many good clinical outcomes have been reported for such periacetabular osteotomies for osteoarthritis of the hips at an early stage. In contrast, the clinical outcome is controversial for those hips at an advanced stage, in which the joint space has partly disappeared. The purpose of this study was to investigate whether TOA is an appropriate option for treatment of osteoarthritis of the hips at the advanced stage by comparing with matched control hips at the early stage.

Between 1998 and 2001, TOA was performed in 104 hips of 98 patients. Sixteen of 17 hips (94%) with osteoarthritis at the advanced stage were examined and compared with 37 matched control hips at the early stage. The mean age at the operation was 48(38-56) and the mean follow-up period was 88 (65-107) months. TOA corrected the acetabular dysplasia and significantly improved containment of the femoral head. No hips had secondary operations including THA. Clinical scores were also significantly improved in both of the groups. In the advanced osteoarthritis cases, there was a tendency for abduction congruity before transposition osteotomy of the acetabulum to reflect the clinical outcome.

TOA is a promising treatment option for the advanced osteoarthritis of the hips as well as for those patients at the early stage when preoperative radiographs show good congruity or containment of the joint.
MINI SUBVASTUS APPROACH FOR TKA: IS IT SAFE IN OBESE?
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Obesity has been associated with degenerative osteoarthritis of knee joint. The overall incidence of osteoarthritis of the knee is also more in patients with obesity. Increasing obesity leads to faster progression of OA, which is due to increased joint load. Body mass index (BMI), dividing an individual’s weight (in kg) by his or her height (in square meters). BMI: Normal = 18.5 to 24.9, Overweight BMI -25-29.9 Obese=30 to 39.9, Morbidly Obese BMI 40 or Greater. Recent article focused on the thigh girth of obese patients and opined that if thigh girth >55cms, subvastus approach should not be utilized, as it is difficult to evert the patella. We believed that obesity should not really cause a problem for the patients undergoing a TKA with the mini subvastus approach as the anatomy of the quadriceps in the obese and the non-obese patient population is the same. We decided to evert the patella only after osteotomy of tibia and the femur.

All patients who underwent primary total knee arthroplasty with minisubvastus approach between January 2006 to July 2007 and who were obese (BMI>30) were included in our study. Out of 425 primary Total knee arthroplasty were performed during this period. Out of these, there were total 97 obese patients with 109 knees which form the part of the study. There were 81 females and 16 males and 12 patients had staged bilateral knee arthroplasty. The weight varied from 63 to 125 kgs. 91 patients had varus deformity of < 15 degree, 15 patients had varus deformity of >15 degree, 3 patients had valgus deformity. The thigh girth in obese group (BMI: 30-40) ranged from 45 to 58 cms with average of 50.17. The thigh girth in morbidly obese (BMI > 40) group ranged between 55 to 67 with average of 61.01 cms. Mini-subvastus approach provided satisfactory exposure in all knees that were operated. In no case was this approach abandoned.

The average surgical time was 90 minutes with range. The average blood loss was 400 cc. The patellar tracking was immaculate in every case and in fact it was difficult to displace patella laterally after 30 degrees of knee flexion. Our 89 patients had flexion of >120 0 ,and 20 patients had flexion of >90 but <120. The knee society score improved from average 42 (range 17-62) preoperatively to 89 (range 72-95) post operatively. The Knee Society functional score improved from 48 (range 15-60) pre operatively to 65 (range 50-80) post operatively.

Mini subvastus approach offers adequate intraoperative exposure even in obese and morbidly obese patients. It did not result in increased complications in our hands even in morbidly obese patients with higher thigh girth. It is extremely patient friendly and its wider use is recommended.
INTER-SUBJECT INVARIANT SCAPULAR AXES FOR GENERALIZED APPLICATIONS
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Introduction: Classical studies have defined axes from prominent scapular landmarks that have been used to synthesise many applications. The morphology of the scapula is however known to be highly variable between individuals1,2,3. This introduces significant variability on the use of these classical axes for various clinical applications. Also, some of the literature applied landmarks were highly dependent on the presence of pathology, thus introducing more variability in the products they parented. This limits accuracy in inter-subject comparisons from such applications. Therefore there is a need to identify and define pathology-insensitive anatomical landmarks that are less variable between individuals than the variability of the overall scapular shape. The aim of this study was to define more scapular axes from clearly identifiable landmarks, analysing these and other classical definitions for the best axis that minimizes variability and is closely related to the scapular clinical frame of reference.

Materials and Method: Fourteen different axes of new and classical definitions from clearly identifiable landmarks were quantified by applying medical images of 21 scapulae. The orientations of the quantified axes were calculated. The plane of the blade of the scapula was defined, bounded by the angulus inferior4, the spine/medial border intersection5 and the most inferolateral point of the infra-glenoid tubercle. This was applied to grade the alienation of the quantified axes from the scapular blade. The angular relationships between individual axes of a scapula were quantified, averaged over the 21 specimens and their standard deviations (SD) applied to grade the sensitivity of each axis to interscapular variations in the others. The volume of data required to define an axis (VDA) was noted for its dependency on pathology. These three criteria were weighted according to relative importance such that 1: axes bearing 10° or more from the blade deviated significantly and were eliminated; 2: insensitivity to scapular morphological variations based on the smallest SD and axes applicability in pathology based on VDA of the remaining axes were graded for the final result.

Results: A least square line through the centre of the spine root was the most optimal medio-lateral axis. The normal to the plane formed by the spine root line and a least square line through the centre of the lateral border ridge was the most optimal antero-posterior axis.

Conclusion: These body-fixed axes are closely aligned to the cardinal planes6 in the anatomical position and thus are clinically applicable, specimen invariant axes that can be used in generalised and patient-specific kinematics modelling.

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INTRAOPERATIVE EMBOLIC EVENTS DURING TOTAL KNEE ARTHROPLASTY WITH USE OF PULSATILE SALINE VERSUS CARBON DIOXIDE LAVAGE
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Elderly patients are at risk of developing cardiopulmonary and cognitive impairment following major orthopaedic surgery. One of the mechanisms believed to be responsible for such complications after total knee arthroplasty (TKA) is the release of embolic debris that may travel from the surgical site, through the lungs, and into the brain following tourniquet release. Removal of fat globules and marrow particulates from bone surfaces prior to pressurization and cementation of prosthetic components may reduce the number and size of embolic particles. We conducted a prospective, randomized clinical trial to compare the effect of carbon dioxide (CO2) gas versus saline lavage on the number and size of embolic particles observed during cemented TKA.

Twenty patients undergoing elective TKA were randomly assigned to one of two groups. In group A, standard high-pressure pulsatile saline lavage was used to clean the resected bone surfaces. In group B, the femoral canal was cleaned using CO2 lavage techniques and the resected bone surfaces were cleaned with a manual saline wash followed by CO2 lavage. All patients received the same TKA implant design. The presence of embolic particles in the heart and brain was intraoperatively monitored using transesophageal echocardiography (TEE) and transcranial Doppler (TCD) techniques, respectively. For each patient, TEE images were analyzed at tourniquet release and during the final range of motion (ROM) assessment prior to wound closure using the following five point cardiac echogenic scoring system: Grade 0: no emboli; Grade I: a few fine emboli; Grade II: a cascade of many fine emboli; Grade III: a cascade of fine emboli mixed with at least one embolus > 1 cm in diameter; and Grade IV: large embolic masses > 3 cm in diameter. The highest grade observed during either tourniquet release or ROM assessment was assigned to each patient. Cardiac emboli were then categorized according to embolic grade as follows: Grade 0 or I = Low; Grade II, III, or IV = High. For analysis of cerebral emboli, the total number of positive counts measured using TCD was recorded for each patient. TEE data were available for nine patients in group A and eight patients in group B. Comparative TCD data were available for seven patients in group A and six patients in group B. Fischer’s Exact Test was used to check for differences between groups.

For cardiac emboli, nine of nine (100%) patients in group A were in the High category based on their TEE grade, with eight patients being Grade II and one Grade III. In contrast, three of eight (37.5%) patients in group B were in the Low category, leaving only five (62.5%) in the High category (p = 0.08). All five group B patients in the High category were Grade II. No patients in group A had cerebral emboli detected using TCD. In group B, three of six patients had one cerebral embolus and the remaining three had none. Three patients in group B were excluded from the comparative TCD analysis due to the presence of a patent foramen ovale (PFO). These three patients with a PFO had one, three, and four cerebral emboli, respectively. No patients in group A had a PFO.

This study examines the effect of pulsatile saline versus CO2 gas lavage on intraoperative embolic events during TKA. Thirty-seven percent of patients in the CO2 lavage group had a Low cardiac echogenic score compared with 0% of patients in the standard pulsatile saline lavage group. A single cerebral embolus was detected in three of six patients in the CO2 lavage group compared with none in the seven patients in the standard pulsatile saline lavage group. Compared to published studies on cerebral emboli in TKA, the overall incidence of cerebral emboli in the current study was very low across both groups. The results of this study suggest that CO2 gas, as compared to pulsatile saline, lavage reduces the number of intraoperative cardiac emboli during total knee arthroplasty.
SCAPULOHUMERAL RHYTHM OF REVERSE SHOULDER ARTHROPLASTIES DURING WEIGHTED AND UNWEIGHTED SHOULDER ABDUCTION
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Reverse shoulder arthroplasty (RSA) is increasingly utilized to restore shoulder function in patients with osteoarthritis and rotator cuff deficiency. There is currently little known about shoulder function after RSA or if differences in surgical technique or implant design affect shoulder performance. The purpose of this study was to quantify scapulohumeral rhythm in patients with RSA during loaded and unloaded shoulder abduction.

Eleven patients with RSA performed shoulder abduction (elevation and lowering) with and without a handheld 3kg weight during fluoroscopic imaging. Three RSA designs were included. We used model-image registration techniques to determine the 3D position and orientation of the implants. Cubic curves were fit to the humeral elevation as a function of the scapular elevation over the entire motion. The slope of this curve was used to determine the scapulohumeral rhythm (SHR).

For abduction above 40°, shoulders with RSA exhibited an average SHR of 1.5:1. There was no significant difference in SHR between shoulder abduction with and without 3kg handheld weights (1.6±0.2 unweighted vs. 1.4±0.1 weighted), nor was there a significant difference between elevation and lowering. SHR was highly variable for abduction less than 40°, with SHR ranging from a low of 1 to greater than 10. For these very small groups, there was no apparent pattern of differences between implant designs having differing degrees of lateral offset.

At arm elevation angles less than 40°, SHR in RSA shoulders is highly variable and the mean SHR (2-5) with RSA appears higher than SHR in normal shoulders (2-3). At higher elevation angles, SHR in shoulders with RSA (1.5-1.8) is much more consistent and appears lower than SHR in normal shoulders (2-4). With the small subject cohort, it was not possible to demonstrate differences between subjects with different implant designs. Ongoing analysis of reverse shoulder function with larger cohort sizes will allow us to refine our observations and determine if there are differences in shoulder function due to implant design, preoperative condition and rehabilitation protocols.
LIGAMENT RELEASES DURING TOTAL KNEE REPLACEMENT DO NOT INCREASE POSTOPERATIVE VARUS-VALGUS LAXITY

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Instability is a major cause for revision surgery in total knee replacement (TKR). With a balanced gap technique, the ligaments are theoretically balanced. However, there is concern that ligament releases needed to align the leg may cause instability. Furthermore, no information is available about the relationship between the amount of varus-valgus laxity directly after implantation and at a later postoperative interval. This prospective clinical study investigated whether ligament releases necessary during total knee replacement (TKR) led to a higher varus-valgus laxity during peroperative examination and after 6 months.

In this prospective cohort study, in 49 patients a primary TKR was implanted using a balanced gap technique. Varus and valgus laxity of the knee was assessed in extension and flexion (70 degrees) per-operative (before and after implant) with a navigation system and post-operative with standardised stress radiographs (both methods 15 Nm stress applied). Knees were catalogued according to ligament releases performed during surgery: no releases, lateral releases, medial releases with posteromedial condyle (PMC), and medial releases with superficial medial collateral ligament (SMCL). ANOVA was used to test between release groups.

At surgery, before and after implantation of the prosthesis, there was no difference in varus or valgus laxity in extension and flexion between knees that did not need a ligament release (n=22), knees with lateral release (n=5), knees with medial SMCL releases (n=15) and knees with medial PMC releases (n=7). Six months after TKR, varus or valgus laxity in extension and flexion was not significantly different between the release categories.

In conclusion, ligament releases of the SMCL, PMC, and lateral structures performed during a balanced gap technique in TKR do not lead to an increased varus-valgus laxity in extension and flexion at 6 months after surgery. Therefore, routine releases of these structures to achieve neutral leg alignment can safely be performed without causing increased varus-valgus laxity. The results of this study suggest that the reported high incidence of revisions for ligament instability after TKR is not likely to be caused by routine ligament releases when a balanced gap technique is used. Apparently, there is not a ligament instability problem as long as the gaps are properly filled with prosthesis components. We believe that the conclusion of this study would also be valid when bone referenced techniques are applied instead of tensors, as long as the gaps created are balanced.
SOFT TISSUE BALANCE IN CRUCIATE-RETAINING AND POSTERIOR-STABILIZED TOTAL KNEE ARTHROPLASTY

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【Purpose】A common difficulty with manually-performed total knee arthroplasties (TKAs) is obtaining accurate intra-operative soft tissue balancing, an aspect of this procedure that surgeons traditionally address through their “subjective feel” and experience with an unphysiological joint condition. We have therefore developed a new tensor for TKAs that enables us to assess for soft tissue balancing throughout the range of motion about the knee with a reduced patello-femoral (PF) joint and femoral component in place. This tensor permits us to intra-operatively reproduce the post-operative alignment of the PF and tibio-femoral joints. The main purpose of this study is to compare ligament balance in cruciate-retaining (CR) and posterior-stabilized (PS) TKAs.

【Methods】Using the tensor, we intra-operatively compared the ligament balance measurements of CR and PS TKAs performed at 0, 10, 45, 90 and 135° of flexion, with the patella both everted and reduced. From a group of 40 consecutive females (40 varus osteoarthritic knees) blinded to the type of implant received, we prospectively randomized 20 patients to receive a CR TKA (NexGen CR Flex) and the other 20 patients a PS TKA (NexGen LPS Flex). The CR TKA group had a mean age of 73.7 ± 1.3 years while the PS TKA group had a mean age of 73.8 ± 1.7 years.

【Results】The mean values of varus angle in CR TKA with the knee at 0, 10, 45, 90 and 135 degrees of flexion were 3.0, 3.2, 2.7, 4.2 and 5.1° with the patella everted, and 3.9, 4.2, 2.5, 2.0 and 2.0° with the patella reduced. The mean values of varus angle in PS TKA at these same degrees of flexion, respectively, were 3.0, 4.1, 6.0, 6.2 and 6.1° with the patella everted, and 3.8, 4.1, 6.3, 6.3 and 4.9° with the patella reduced. While the ligament balance measurements with a reduced patella of PS TKAs slightly increased in varus from extension to mid-range of flexion (p<0.05), these values slightly decreased for CR TKA (p<0.05). Additionally, the ligament balance at deep knee flexion was significantly smaller in varus for both types of prosthetic knees when the PF joint was reduced (p<0.05).

【Conclusion】Accordingly, we conclude that the ligament balance kinematic patterns differ between everted and reduced patellae, as well as between PS and CR TKA.
Uncemented hip implants commonly have porous coated surfaces that enhance the mechanical interlock with bone, encourage bone ingrowth and promote the formation of a stable interface between prosthesis and bone. However, the presence of tissue, either fibrous or with parts of osseous tissue, at the interface between the implant and the bone has been commonly observed after a few years in vivo. The exact mechanisms that govern the type of tissues formed at the interface are not fully understood and several theories have been proposed. This study aims to employ finite element analysis (FEA) to simulate tissue formation and differentiation around the AML (DePuy, Warsaw, USA) femoral implant by employing a tissue differentiation algorithm based on a mechanoregulatory hypothesis of fracture healing.

FE models of the femur were generated using computer tomography (CT) scans. The AML prosthesis was then implanted into the bone and a granulation tissue layer of 0.75mm was created around the implant. The mechanoregulatory hypothesis of Carter et al (J.Orthop, 1988) originally developed to explain fracture healing was used with selected modifications, most notably the addition of a quantitative module to the otherwise qualitative algorithm. The tendency of ossification in the original hypothesis was modified to simulate tissue differentiation to bone, cartilage or fibrous tissue. Normal walking and stair climbing loads were used for a specified number of cycles reflecting typical patient activity post surgery.

The transformation of granulation tissue to one of the three simulated tissue types was evident as the iterations progressed. The majority of the tissue type formed initially was cartilage and bone (~40% each), and occupied the mid to distal regions of the implant respectively. After tissue stabilisation, the prominent tissue type was bone (65%), occupying most of the mid-distal regions with a significant decline in cartilage tissue formed. This has been shown in clinical retrieval studies with the same implant, where maximum bone ingrowth is in the mid-distal regions of the implant, directly corresponding to the region where there is minimal micromotion. This would be the case with a diaphyseal fixation, which most AML prostheses employ for stability. Fibrous tissue formation was limited to the proximal-medial regions (~10%), with the remainder of the proximal regions filled with cartilage tissue. In addition, predicted bone formation was along the lines of the more stable cartilage tissue as opposed to directly replacing fibrous tissue. The formation of bone would require repeated periods of minimal micromotion and stress at the interface tissue; this was facilitated by the presence of cartilage tissue around the mid regions of the implant. The micromotion and interface stresses in the proximal regions of the implant were too high to encourage bone ingrowth, resulting in the presence of tissue that remained fibrous throughout the process.

The FE model, employing a very simple tissue differentiation hypothesis and algorithm was able to predict the formation of different tissues at the interface. Initial bone formation was rapid, occupying the distal regions of the implant, and then gradually occupying a larger portion of the mid-regions around the implant. The proximal regions were largely occupied by a combination of fibrous and cartilage tissue. Overall, the presence of bone and cartilage tissue accounted for nearly 85% of the tissue formed which would suggest a very stable interface as predicted by the Carter’s hypothesis.
WHICH VARIABLES DETERMINE THE OUTCOME OF REVISION TOTAL KNEE ARTHROPLASTY?
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Methodology: A retrospective review based on a prospective database was performed on 146 consecutive revision TKA’s. An independent observer measured clinical outcomes using the Knee Society Knee (KS) and Function Score (FS). X-ray evaluation, including rating of radiolucent lines, tibiofemoral and patellofemoral alignment, was carried out by an independent radiologist. ANOVA was used for statistical analysis, with significance set at p≤0.05 (SPSS version 15.0). Post-hoc Bonferroni testing was carried out for single variables including primary cause of failure, age at revision surgery, time span between index operation and revision, type of index operation, partial or total revision and the performance of a tuberosity osteotomy.

Results: 146 files were available in 135 patients. 16 patients deceased (17 knees) during the follow-up period and 2 patients (2 knees) were lost to follow-up. 117 patients (127 knees) were available for evaluation. Age at revision surgery averaged 67.7 years (range 32.3-88.1). Mean follow-up time was 4.5 years (range 1 -14). Patients had revision TKA between 51 days and 16.1 years (average 4.7 years) after the index TKA. 54% of the early revisions were due to infection and instability, 55% of late revisions were caused by polyethylene-wear and loosening. The mean postoperative KS was 70.8 with a mean improvement of 43.2 points as compared to preoperative. The mean postoperative FS was 52.9 with a mean improvement of 25.4 points. Grouping outcomes according to cause of failure of the index TKA gave the following ranking from better to worse, without being significant: wear (n=15; KS 80.8; range 43-99, SD 17.5), loosening (n=44; KS 75.8; range 15-100, SD=21.2), malalignment (n=19; KS 70.0; range 9-95, SD 25.9), instability (n=33; KS 68.2; range 5-100, SD 24.1), others (n=16; KS 66.7; range 10-100, SD 25.9), and infection (n=21; KS 64.2; range 3-100, SD 31.7). Survivorship at 5 years was 90.0% (CI 86.4% - 93.6%), at 10 years 84.6% (CI 77.0% - 92.3%) and at 14 years 84.6% (CI 37.7% - 131.6%). Significant better outcomes were seen with late revisions, index operation being partial knee replacement and older age at revision. More failures (p=0.002) were seen with early revisions. In 32.6% of the patients radiolucent lines of ≥1 mm were observed. Points were granted with the use of a Radiolucency Scoring Scheme. Patients with less than 4 points (n=87, mean KS 71.2) had better outcomes than patients with 4 or more points (n=8, mean KS 56.4). 87% of patients were aligned within 4° of mechanical axis.

Conclusion: 1. Outcomes of revision TKA are inferior to primary TKA. 2. Early failures were mainly caused by infection, instability, malalignment. 3. Grouping revision TKA’s to etiology of failure did not lead to significant differences in outcomes. 4. Significant better outcomes were reported for late revisions, patients with older age at revision surgery and partial knee replacement. 5. Survivorship analysis was significally better for late than for early revisions.
Recent fluoroscopic analyses evaluating the kinematic function of TKAs have demonstrated significant variability among patients with identical implant designs, suggesting surgical technique also influences function. To help explain these kinematic variations, we used intraoperative compartment pressure sensors to assess balancing at trial reduction and ROM then correlated these intraoperative findings with patients’ postoperative kinematics, assessed using video fluoroscopy.

This study involved 16 patients implanted with a posterior cruciate-sacrificing LCS TKA using a balanced gap technique. After releases in extension, the femur was rotated the appropriate amount to create a rectangular flexion gap relative to the cut tibial surface. As the knee was taken through a ROM from 0-120°, the sensors (placed on the tibial insert trial) dynamically measured the magnitude and location of compartment pressures throughout the ROM. Six to nine months postoperatively, all patients performed successive weight-bearing deep knee bends to maximum flexion under fluoroscopic surveillance. Each patient’s femorotibial contact positions and liftoff values were compared to their respective intraoperative compartment pressure findings to establish correlations.

Fluoroscopic results correlated closely with intraoperative compartment pressures and balance data. Three of the 16 patients had condylar liftoff: two patients experienced liftoff in flexion and one in extension (medial). The patient who experienced medial liftoff in extension had decreased medial compartment pressure and a slight valgus malalignment (7° of anatomic alignment). Two of the 13 patients without liftoff had abnormal compartment pressures in extension. In both cases, mechanical axis alignment resulted in loading of the lax compartment with weight-bearing. The other 11 patients had normal compartment pressures in extension and no condylar liftoff. One of these patients had slight valgus (7°) and another slight varus malalignment (4°), but both had normal compartment pressures. Despite good compartment balance, average tibiofemoral rotation was inadequate; three of 16 patients experienced opposite axial rotation with flexion. Extensive ligament release did not always result in equal compartment pressure magnitudes and distributions; compartment balance was influenced by the nature of the release.

These data suggest that liftoff may require both a compartment pressure imbalance and abnormal alignment that together exacerbate the laxity with physiologic loading. Previous kinematic studies of LCS knees have shown that the balanced gap technique produces wellbalanced compartment pressures, resulting in TKAs with little liftoff and very good translational and rotational characteristics. Therefore, while a given implant design may have inherent kinematic tendencies, surgical technique may significantly impact kinematic performance. To optimize implant kinematics and subsequent TKA function and longevity, it may be important for surgeons to accurately balance the flexion and extension gaps. Characteristic compartment pressure patterns and distributions for various ligament releases may shed some light on less than optimal rotational kinematic performance.
A GENERALIZED CROSS-SHEAR WEAR MODEL FOR USE IN JOINT REPLACEMENT DESIGN
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Cross-shear has been shown to increase ultra-high molecular weight polyethylene (UHMWPE) wear in pin-on-disk, total knee, total hip, and spinal disc replacement testing. Computer modelling of implant wear holds promise for improving efficiency in the development of new implant designs, but it is desirable to accurately account for the effects of cross-shear in the computational simulation. Several studies have sought to propose a quantitative metric for cross-shear in multidirectional sliding and to correlate average cross-shear intensity with apparent wear rate measured in experiments. The apparent wear rate accounts for the total volume loss from all points on the UHMWPE surface. In principle, if the cross-shear metric correlates with experimental wear rates, it is then possible to predict an estimated wear rate for any arbitrary set of kinematic inputs. UHMWPE wear may then be simulated numerically with some form of Archard’s law.

One limitation of the above approach is that counterface kinematics are homogenized by the use of a spatially and temporally averaged apparent wear rate. In a sliding contact interface of a joint implant in vivo, the intensity of cross-shear wear may vary with time and location on the surface. To address this variation we have proposed a novel cross-shear metric ($x^*$) and developed a modified form of Archard’s law that is capable to differentiate between unidirectional and multidirectional sliding wear. The wear model and $x^*$ have been implemented in an explicit finite element framework (ABAQUS) that is capable of quantifying wear from any number of wear surfaces (e.g., front side, backside, post) with completely general geometry and loading conditions.

Preliminary validation of $x^*$ and the wear model have been performed by comparison with data from the open literature. Cross-shear metric $x^*$ is easy to compute, exhibits invariance to the choice of kinematic reference frame, and is able to reliably distinguish between similarly shaped sliding paths of different lengths – all improvements compared to cross-shear metrics described elsewhere. The wear model that incorporates $x^*$ has shown good agreement with pin-on-disk and cervical disc replacement wear results previously reported. Ongoing research focuses on demonstrating similar validity of the model for cross-shear wear in hip and knee replacements.
In order to understand the actual weight-bearing condition of lower extremity, the three dimensional (3D) mechanical axis of lower limb was compared with the loading direction of ground reaction force (GRF) in standing posture.

Three normal subjects (male, 23-39 yo) participated in the study. A bi-planar radiograph system with a rotation table was used to take frontal and oblique images of entire lower limb. Each subject’s lower limb was CT scanned to create 3D digital models of the femur and tibia. The contours of the femur and tibia in both radiographs and the projected outlines of the 3D digital femur and tibia models were matched to recover six-degree of freedom parameters of each bone. The 3D mechanical axis was a line drawn from the centre of the femoral head to the centre of the ankle. A surface proximity map was created between the distal femoral articular surface and the proximal tibial articular surface. A force plate was positioned on the rotation table to measure GRF during biplanar X-ray exposure. Each subject put one’s foot measured on the force plate and the other on the shield. Bi-planar radiographs were taken in double-limb standing, double-limb standing with toe up in the leg measured, and single-limb standing. The anterior and medical deviations of the loading direction of GRF from the 3D mechanical axis were determined at the proximal tibia and normalized by the joint width in anteroposterior direction and by the joint width in lateral direction.

For all subjects the passing points of the 3D mechanical axis at the proximal tibia were almost in the middle of the joint width in lateral direction. Compared to the 3D mechanical axis, the loading direction of GRF passed through the anterior region in double-limb standing and single-limb standing, and anteromedial region in single-limb standing. The normalized medial deviation was significantly greater in single-limb standing than in double-limb standing (p=0.023). The separation distance tended to decrease in the medial compartment in single-limb standing, and to increase in toe up in the entire region.

Deviation of the loading direction of GRF from the 3D mechanical axis at the proximal tibia varied among standing postures, relating to the change in weightbearing condition as indicated in the separation distance map. These results provide the mechanical perspective related to the causes and progression of knee OA and may contribute to the improvement of surgical treatments such as arthroplasty and osteotomy.
CLINICAL OUTCOMES FOR MINIMUM 5 YEARS AFTER COMPUTER-ASSISTED TOTAL KNEE ARTHROPLASTY
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Background: The use of computer-assisted navigation system had proved to result in consistently accurate alignment of prosthesis in total knee arthroplasty (TKA), however, the clinical midterm to long-term results remains unclear. The objective of this study is to investigate whether clinical results after computer-assisted TKA is superior to the conventional surgical method at midterm, minimum for 5 years follow-up.

Materials: From October 2002 to May 2003, we implanted 30 posterior stabilized total knee prostheses (PFC Sigma; DePuy Inc) using a computed tomography-free navigation system (Vector Vision) for patients diagnosed as osteoarthritis. A control group of 30 matched total knee prostheses of the same type were implanted via a classical, surgeon-controlled technique. Midterm 5 year clinical results including range of motion and Knee Society Clinical Rating Score were compared with these groups. The navigation group was comprised of 23 women and 4 men with a mean age of 81.0 years (range: 56-89 years) at final follow-up and the manual group was comprised of 23 women and 4 men with a mean age of 78.2 years (range: 51-87 years). The results were analyzed statistically and differences of \( p < 0.05 \) were considered statistically significant.

Results: Mean follow-up duration was 68.9 months (range: 60-78 months) in the navigation group and 72.8 months (range: 60-80 months) in the manual group. Total 6 patients (3 patients in each group) were lost to follow-up because of their death or lost contact. The follow-up rate was 90 %. No revision or reoperations were required in this study. The average preoperative knee society knee score (KSS) and knee society functional score (KSFS) in the navigation group were 52.9 points (range: 43-77 points) and 51.4 points (range: 25-80 points), respectively and the average postoperative scores were 89.7 points (range: 64-100 points) and 79.7 points (range: 40-100 points), respectively. The average preoperative KSS and KSFS in the manual group were 50.7 points (range: 43-77 points) and 50.3 points (range: 10-80 points), respectively, and the average postoperative scores were 89.6 points (range: 70-100 points) and 75.2 (range: 5-100 points), respectively. No significant differences were noted between the two groups both pre- and postoperatively. The average preoperative range of motion (ROM) in the navigation group was 105.0° (75°-125°); -8.6° (range: 0° to -25°) for extension and 113.6° (range: 85°-135°) for flexion, respectively. The average postoperative ROM was 113.8° (85°-130°); -1.0° (range: 0° to -10°) for extension and 117.0° (range: 105°-130°) for flexion, respectively. The average preoperative ROM in the manual group was 102.5° (65°-140°); -10.2° (range: 0° to -25°) for extension and 112.7° (range: 75°-140°) for flexion, respectively, the average postoperative ROM was 106.9° (80°-130°); -0.0° (range: 0°) for extension and 106.9° (range: 80°-130°) for flexion, respectively. Although no significant difference was found between preoperative ROM for the two groups, the navigation group showed a significantly better ROM compared to the manual group.

Conclusions: Minimum 5-year follow-up of computer-assisted TKA used in the present study revealed that better ROM was achieved, compared with the conventional surgical method. KSS and KSFS were equally good among these two groups. The results focused on the radiographically malaligned patients and further longer follow-up were needed to reveal whether computer-assisted TKA has true clinical benefits compared with the conventional surgical method.
MINALLY-INVASIVE MANAGEMENT OF KNEE OSTEOARTHRITIS USING COMPARMENTAL ARTHROPLASTY COMBINATION AND ASSOCIATION WITH OSTEOTOMY

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Treatment of limited osteoarthritis of the knee remains a challenging problem. Total knee arthroplasty may provide a reliable long-lasting option but do not preserve the bone stock. In another hand, compartmental arthroplasty with or without osteotomy is a bone and ligament sparing solution to manage limited osteoarthritis of the knee. Considering the renewed interest for combined compartmental implants we aimed to evaluate the average 12-year clinical and radiological outcome of a consecutive series of patients treated with compartmental knee arthroplasty combined or not with osteotomy.

We retrospectively reviewed all 255 patients (274 knees) treated in our institution with a compartmental arthroplasty combined or not with an osteotomy for a diagnosis of either bi or tricompartmental osteoarthritis of the knee between April 1972 and December 2000. The series included: 100 cases of combined lateral and medial UKA, 77 combined medial UKA and patello-femoral arthroplasty (PFA), 19 cases of combined Bi-UKA and PFA, 14 cases of UKA and high tibial osteotomy (HTO), 7 cases of combined lateral-UKA and PFA and HTO, 16 cases of combined lateral-UKA and PFA and 13 cases of combined bi-UKA and HTO. Patient’s selection and surgical indication was based on the physical exam and on the radiological analysis including full-length x-rays and stress x-rays. Clinical and radiological evaluations were performed at a minimum follow-up of 5 years (mean, 12 years; range, 5-23 years) by an independent observer.

The Knee Society knee and function scores improved respectively from 43 to 89 and from 47 to 90 at last-follow-up. The mean active knee flexion improved from 116° ± 6° (range, 100°- 145°) pre-operatively to 129° ± 5° (range, 117°-149°) at final follow-up. The restoration of the mechanical axis of the knee was achieved in all the cases. Dramatic failures were observed for patient with uncemented PFA. Considering revision for any reason as the endpoint, the 17-years survivorship was 0.68 (95% confidence interval: 0.62 to 0.75).

Our results suggested that combined compartmental arthroplasty with or without osteotomy can restore function and alignment of the knee in compartmental arthritis. This combined surgery represents a bone and ligament sparing alternative to TKA which can be considerate as a true minimally invasive solution.
ROUTINE CLINICAL OUTCOME ASSESSMENT OF THE SHOULDER IS VALID USING INERTIA SENSOR BASED MOTION ANALYSIS.
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Introduction: In clinical orthopaedics questionnaire based outcome scores such as the DASH shoulder score suffer from a ceiling effect, subjectivity and the dominance of pain perception over functional capacity. As a result it has becomes increasingly difficult to clinically validate medical innovations in therapy or implants and to account for rising patient demands. Thus, objective functional information needs to be added to routine clinical assessment. Motion analysis with opto-electronic systems, force plates or EMG is a powerful research tool but lab-based, too expensive and time consuming for routine clinical use. Inertia sensor based motion analysis (IMA) can produce objective motion parameters while being faster, cheaper and easier to operate. In this study a simple IMA shoulder test is defined and a.) its reliability tested, b.) its diagnostic power to distinguish healthy from pathological shoulders is measured and c.) it is validated against gold standard clinical scores.

Methods: An inertia sensor (41x63x24mm³, 39g) comprising a triaxial accelerometer (±5g) and a triaxial gyroscope (±300°/sec) was taped onto the humerus in a standardised position. One-hundred healthy subjects without shoulder complaints (40.6 ±15.7yrs) and 40 patients (55.4 ±12.7yrs) with confirmed unilateral shoulder pathology (29 subacromial impingement, 9 rotator cuff pathology, 2 other) were measured. Two motion tasks (‘hand behind the head’ and ‘hand to the back’) based on the Simple Shoulder Test (SST) were performed on both shoulders (three repetitions at self selected speed). Motion parameters were calculated as the surface area described by combing two angular rate signals of independent axes (ARS) or by combing the angular rate and the acceleration of a single axis (COMP score). The relative asymmetry between two sides was scored.

Results: The test produced high intra- ($r^2 \geq 0.88$) and inter-observer reliability ($r^2 \geq 0.82$). Healthy subjects scored a mean asymmetry of 9.6% (ARS) and 14.6% (Comp). Patients with shoulder complaints showed $>3\times$ higher asymmetry (ARS: 34.1%, Comp: 42.7%) than the healthy controls (p<0.01). Using thresholds (ARS: 16%, Comp 27%) healthy and pathological subjects could be distinguished with high diagnostic sensitivity (e.g. ARS: 97.5% [CI: 85.3-99.9%]) and specificity (e.g. COMP: 85.5% [CI: 76.1-91.1%]). Both asymmetry scores were strongly intercorrelated ($r^2=0.76$) as were the clinical scores ($r^2=0.62$, DASH-SST). Asymmetry and clinical scores were hardly correlated ($r^2<0.14$).

Discussion: The IMA shoulder test and asymmetry scores showed high reliability meeting or exceeding common clinical scores. With a fast assessment of a simple ADL tasks (test duration <60s) it was possible to provide diagnostic power at clinically usable level making routine clinical application feasible even by nonspecialist personnel. Weak correlations with the clinical scores show that the new test adds an objective functional dimension to outcome assessment which may have the potential to differentiate new treatments or implants required to trigger new therapeutic innovation cycles. Similar motion tests and parameters could also serve lower extremity outcome assessment.
Ligament balancing can be difficult to perfect in total knee arthroplasty (TKA), where current surgical practice is subjective and highly dependent on the individual surgeon. Proper ligament balancing contributes to postoperative stability, prosthetic alignment, and proprioception. Conversely, imbalance is linked to increased wear rates of the polyethylene component within the implant and, in turn, early surgical revision. With the end goal of quantification of joint compartmental pressures, pressure sensor arrays have been designed to quantify contact stresses within the knee during TKA.

Flexible, capacitive pressure sensors are designed as simple parallel plates, enabling a robust solid state design. Modification of cleanroom microfabrication processes enable realization of these arrays on polyimide (common in microdevices), and polyethylene (common in joint replacements). Readout circuitry implements an Analog Devices capacitance to digital chip and output is compared to direct LCR meter data. Testing verifies the highly linear response of the sensors with applied normal loads corresponding to pressure magnitudes present in passive (intraoperative) knee flexion. Spatial resolution of the arrays is 0.5 mm, with a critical dimension of 25 micrometers, allowing the magnitude and location of forces to be accurately recorded.

The MEMS pressure sensors are mounted on a tibial trial, with the body of the trial housing all circuitry. The sensors are read sequentially, and the data undergoes analog to digital conversion prior to wireless data transmission at 2.4 GHz. An Instron machine is used for compressive loading for laboratory calibration and testing. This paper outlines device fabrication, readout circuit implementation, and preliminary results.
A SIMPLEx, LASER-GUIDED SYSTEM FOR PRESCRIBING ACETABULAR CUP INCLINATION ANGLE IN TOTAL HIP ARTHROPLASTY

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Achieving the correct inclination angle for the acetabular component in total hip arthroplasty (THR) can be technically challenging. The aim of this study is to validate the use of a simple, laser-guided system to address the acetabular cup inclination angle intraoperatively and quantify its accuracy and repeatability across users.

A simple inclinometer system was manufactured, consisting of a laser that snaps into both the inclinometer and the handle of a standard trial cup impacter. The system functions as follows: 1) desired inclination angle is set on the inclinometer, 2) inclinometer is positioned on the acetabulum, 3) laser beam is projected onto and marked on a screen outside of the surgical exposure, 4) the impacter is reoriented in the acetabulum until the laser beam aligns with the recorded mark on the screen.

A validation study was performed on this system using intact cadavers (N=4). A THR-specific Trial acetabular components were installed unilaterally in each donor using both the laser inclinometer system with an in-line mounted intraoperative navigation system (NaviVision, Vector Vision Hip 3.1, BrainLab) serving as the measurement standard. Three orthopaedic surgeons participated in the study, two experienced with the device (“experts”) and one “novice”, and each surgeon performed two sequential validation experiments: 1) 10 trials at a set device inclination angle, and 2) 5 trials of matching the trial cup placement to this set angle.

Using the laser-guided system, the inclination angle of the trial cup deviated from the desired orientation by 1.1±0.9° (mean st. dev; range: 0-3°) for all specimens across all operators. The corresponding error in anteversion angle was 1.4±1.3° (range: 0-5°). There was no difference in inclination angle between expert and novice surgeons (1.0±0.8° versus 1.1±1.2°, respectively; p>0.10 for unpaired t-test). To set the desired inclination angle on the trial cup, original and final laser target positions were within 4.1±2.5 cm at 1 m screen placement.

Results suggest that the laser-guided system has sufficient accuracy and repeatability for use intra-operatively. Inclination angles differed from prescribed angles by 1° on average, and malalignment in anteversion was subclinical, ≤5° for all cases. Furthermore, the tolerance for laser re-alignment sufficiently large (5-10 cm) to make the device functional intraoperatively. Future work will focus on expanding the sample size and correcting simple design limitations in the device.
THE USE OF HIP MOTION SIMULATIONS TO CREATE A NEW HIP NAVIGATION SYSTEM
Robert Thornberry

Navigation and hip impingement simulation software has been available for over 10 years. Although hip implant retrieval analysis supports a clinical need for hip navigation, the current commercially available systems fail to provide the level of accuracy, cost, ease of use, and intraoperative functionality to be widely accepted. With the addition of highly accurate hip motion simulations that model all possible combined hip motions, it is felt hip navigation can become both simpler and more robust. A new navigation system is proposed that should operate with an increased level of accuracy, ease of use, and functionality.

Materials and Methods: Simulations of native and implant hip motions to impingement were modeled in HipNav a noncommercial validated hip navigation and simulation program. Implant simulations and simulations based on 30 normal hip high resolution CT scans were performed. Further, 30 normal cadaver hips were studied by optical tracking navigation technologies with modified BrainLab Vectorvision software. The results were graphic represented in 3-D data graphs representing all normal combined hip motions. Flexion/extension was graphed on one axis, abduction/adduction and internal rotation/external rotation on the other two axes. The graphs were modeled in Maple software and then for ease of presentation converted to 3D StudioMax for clarity. The simulations were also performed on CAD implant models all implantation positions within 2 standard deviations of implantation error. This was based on current CT based literature on hip implantation variability. Modeling of augmented cup liners and liner positions as well as modeling of 28mm, 32mm, and 36 mm femoral head sizes were also performed. Graphic representations of all hip motion studies were superimposed on other normal motion graphs clearly demonstrating any range of motion deficiencies. A proposed “gizmo” femoral head neck trial device (with a unique neck geometry that forces impingement) was modeled in all optimal and sub-optimal orientations. Ranges of motion simulations to impingement were then recorded. This created unusually shaped “tube graphs” of a unique character. These unique data graphs provide a “fingerprint” of the relative orientation of the femoral and acetabular components. These data sets are then stored as a reference. When performing a range of motion to impingement intra-operatively with the “gizmo” trial head/neck device, this “fingerprint” can be kinematically obtained and matched to one of the stored reference files. This method allows the determination of implant orientations without a registration step.

Results: Many questions regarding implant positioning, head size, use and placement of augmented liners were readily and clearly demonstrated with this methodology. The 28 mm head implants could not recreate the normal hip motions that were recorded from the cadaver studies regardless of implant position. Augmented liners increased impingement to a dramatic degree when place in the posterior or superior positions. The loss of motion to impingement due to these augmented liners was equivalent to over-anteverting the cup 30 degrees. The “gizmo” device due to its large neck and unique geometry is able to force impingement resulting in the creation of unique data sets that can determine combined anteversion and cup abduction without CT, or any registration of the pelvic plane and with the patient in any position on the OR table. The use of statistical shape modeling of individual patient X-rays will further improve accuracy of this methodology.

Discussion: This method of combining the strengths of navigation and simulation creates a powerful new tool that may allow intra-operative hip navigation to become commonplace and improve the ability of the surgeon to provide a more successful and predictable surgical result for his patients. The problems of ease of use, accuracy and intra-operative functionality are significantly improved with this new proposed method. The addition of this technology to existing optical tracking systems is not difficult and the additional hardware and software required to implement this solution is readily available. The ability of this method not to require a preoperative CT or intra-operative pelvic plane registration eliminates all registration errors as a contributing cause.
of overall combined implantation error. Although inherently reasonable, this proposed method is not yet commercially available and has not been clinically proven to reduce dislocations and impingements in patients. It remains a work in progress.
Numerous investigators have described chondrogenic differentiation of bone marrow stromal cells obtained from both murine and human sources over the past decade. The ease of access and large available quantity of adipose tissue, however, makes Adipose-Derived Stem Cells (ADSC) a far more practical alternative for clinical applications. Therefore, the primary goal of this research endeavor is to achieve chondrogenic differentiation of ADSC. Previous work had also demonstrated that bone morphogenetic protein receptor 1A (BMP receptor 1A) signaling is required for postnatal maintenance of articular cartilage. In fact, cartilage within the joints of transgenic mice deficient in BMP receptor 1A rapidly degenerates after birth in a process resembling accelerated human osteoarthritis. Based on this evidence, we used a lentiviral vector to increase expression of BMP receptor 1A by our isolated stem cells in order to direct their differentiation into the chondrocyte lineage.

We harvested subcutaneous adipose tissue intraoperatively from consenting patients undergoing elective lipoplasty and panniculectomy procedures. The stromal vascular fraction was isolated from this tissue and further refined by passaging in selective media to yield a stable population of ADSC in primary culture. Both the identity and homogeneity of this stem cell population was confirmed using adipogenic induction media and differentiation cocktails. In addition, we subcloned an expression plasmid containing the BMP receptor 1A locus in tandem with green fluorescent protein (GFP) under the transcriptional control of a single promoter. This plasmid was packaged into a lentiviral vector to provide a reliable method of achieving both genomic integration and long-term expression of the BMP receptor 1A gene. Hence, transduction of ADSC using this vector resulted in overexpression of BMP receptor 1A by these multipotent cells. The GFP was then utilized to screen and enrich the ADSC population for stem cells with a robust expression of BMP receptor 1A. The ADSC that overexpressed BMP receptor 1A were found to achieve chondrogenic differentiation after 13 to 16 days of in vitro culture, as revealed by immunohistochemistry assays for the biomarkers of articular cartilage (type II collagen and the proteoglycan aggregan).

Our results demonstrate that stem cells derived from the adipose tissue of a patient represent a viable means of culturing autologous chondrocytes in vitro for future implantation at the site of osteochondral defects. This method of attaining cartilaginous regeneration is intuitively appealing, given the minimal donor site morbidity associated with removing subcutaneous fat. By transducing the ADSC with a lentiviral vector, we have also collected further evidence implicating the critical importance during chondrogenesis of signaling mediated by the BMP receptor 1A. Further tissue engineering studies are now in progress to evaluate the ability of ADSC to differentiate into chondrocytes after seeding onto polycaprolactone polymer scaffolds.
Wireless technologies and their use in the medical field have become much more widespread and important in the last decade. Whether it is a doctor carrying a personal digital assistant, the hospital WLAN, RFID asset tracking systems, telemetry-based Point-of-Care systems, or implanted wireless devices, wireless systems play an important role in the underlying technologies utilized by a hospital. Conversely, wireless technologies are not widely used in computer assisted orthopaedic surgery (CAOS), mainly due to their poor performance in the operating room (OR). The large amount of metallic interference found in the OR can severely degrade wireless signals. This can cause failure in wireless digital communication and large errors in 3-D tracking when using wireless signals for 3-D positioning.

We have developed a wireless positioning system based on ultra wideband (UWB) technology which achieves mm-range 3-D dynamic accuracy and can be used for intraoperative tracking in CAOS systems. This system can be used to track smart surgical tools in the OR and also for registration of bones and conventional (non-smart) surgical tools. UWB technology also has the potential for high data rate digital communication. The potential of highly accurate 3-D tracking combined with high data rate digital communication make UWB an attractive wireless technology for future CAOS systems and provides a strong backbone for smart surgical tools.

We have run various experiments with our UWB system in an OR both during orthopaedic surgeries and when the OR was empty. We have obtained time domain and frequency domain data, which has been analyzed to show the effects of transmitting UWB wireless signals in the OR. The implications of the OR environment on 3-D positioning accuracy and also high data rate digital communication will be presented. The final conclusions show the potential of UWB for wireless smart surgical tools which can be tracked in real-time with mm-range and even sub-mm range 3-D accuracy.
Vascular injury associated with hip surgery is a rare but serious complication. Hip surgeons need to understand the vascular anatomy around the acetabulum to avoid vascular injury. The aim of this study was to visualize the pelvic vascular structures thorough the osseous acetabulum using 3DCT angiography and to describe the three-dimensional relationship between the vessels and the acetabulum. A total of 100 patients who took 3DCT with intravenous contrast for intra-pelvic neoplastic disease were randomly chosen. Those patients with hip disease were excluded. Three examinations were performed. First, dual-phase helical CT data were transferred to a workstation (M900;Zio,Tokyo,Japan) and 3D visualizations of the vascular structures through the pelvis were reconstructed. Second, location of the external iliac, femoral and obturator vessels were investigated in axial CT images. Finally, influence of the age factor on the anatomical courses of the external iliac vessels was assessed.

Reconstructed 3D images were able to provide spatial relationship between courses of the pelvic vascular structures and the acetabulum. We could visualize the pelvic vascular structures thorough the pelvis from similar operative viewpoints. Axial CT examinations revealed the external iliac vessels locate very closely to the pelvis as they exit the pelvic cavity. Especially, the left side vessels and vein were closer to the pelvis. The femoral vessels became closer to the acetabular edge with traveling distally. At the distal half of the acetabulum, the femoral vessels located just ventrally to the anterior acetabular edge. The obturator vessels courses inferiorly along the quadrilateral surface behind the acetabulum, they became very close to the inner cortex or the acetabulum. Straight type of the anatomical course of the external iliac vessels was the most common configuration in young patients, curved and the tortuous types were present in older patients.

The results of this study are useful to understand the anatomical orientation of the vessels around the acetabulum. To avoid vascular injuries in hip surgery, knowledge of the vascular orientation is of critical importance for the hip surgeon.
SAFETY CLEANING METHOD OF OSTEOSYNTHESIS PLATE AND SCREW FOR POSSIBILITY REUSE IN DEVELOPING COUNTRY
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The socio-economic conditions in many developing countries impede widespread general use of the assets of biomedical technology. In orthopedics this becomes evident from the large-scale, though illegal, reuse of osteosynthesis plates and screws. Scientific research into the issue of the safe reuse of osteosynthesis materials from a biological point of view has never been done. Therefore the aim of this study is to determine whether plates and screws after simple cleaning, applying means which are available in developing countries, are safe from a biological point of view. Cleaning methods evaluated include a toothbrush, water, detergent and bleach. X-ray photoelectron spectroscopy analysis of cleaned surfaces and water contact angle measurements indicate that application of these methods yield surface characteristics similar to those of new, sterilized plates. If desired, bleach can be applied without affecting the surface properties of the materials. Subsequently, the reactivity of a mammalian monolayer in response to a used screw (ISO-10993-5) and endotoxin release (USP 27-NF 22) was evaluated, showing that all screws tested are non-cytotoxic with endotoxin release within the requirements of the FDA. This study shows that reuse is not necessarily unsafe from a biological point of view.
THE ROLE OF SILVER-COATED TUMOURAL PROSTHESIS IN THE PREVENTION OF FUNGUS INFECTIONS: EXPERIMENTAL IN VITRO STUDY

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Introduction: It is noted that infections make up the most feared complications of prostheses’ surgery in orthopaedic implants after resection of primary or secondary cancer of limb bones. The causes must be attributed to the entity of the skeletal resection and of surrounding soft tissues sacrifice, to the duration of surgery and to the pre-operative cycle of chemotherapy or radiotherapy. Infections of prostheses in oncology are caused mainly by bacteria present either in isolated strains or in poly-microbial associations, and most recently fungus infections have begun to be found, in immunodepressed patients. Candidemia makes up an important cause of systemic infections in immuno-compromised oncological patients, who received high doses of chemotherapy; moreover candidemia represents a high risk of hospital sepsis. It is noted that the behaviour of the Candida is interpreted through the production of a biofilm and then the inhibition of the production of the biofilm itself is translated into a potential antifungal effect. From the analysis of the literature a protective role carried out by the silver coating of the tumoural prostheses towards the bacterial infections is deduced. It is noted, in fact, the antimicrobiotic effect of medical devices coated in silver; in particular in studies conducted in animals favourable results were demonstrated on bacterial adherence of titanium devices coated with silver. The aim of the study was to evaluate in vitro the inhibition of the production of biofilm by different strains of Candida in the presence of titanium and titanium coated with silver.

Materials and methods: Six strains of Candida were analyzed: 2 strains of C. albicans, 2 of C. tropicalis and 2 of C. parapsilosis. The fungal strains were stratified on discs of pure titanium, a material in which implants of tumoural prostheses are made, and furthermore on discs of titanium coated in silver, and the ability of the fungus to produce protective biofilm on different substratum was evaluated. All of the studies were conducted 3 times. The adherence to the biofilm was measured by semi-quantitative, colormetric and spettrophotometric methods according to standardized protocols.

Results: The spettrophotometric analysis demonstrated a statistically significant reduction of the production of biofilm by fungus strains that came in contact with titanium coated in silver compared to pure titanium in all of the strains that were examined, attested by the fact that the silver creates a micro-environment unfavourable for fungus growth.

Conclusion: The analysis of the results demonstrated that the Silver coating of the oncological prosthesis made an unfavourable micro-environment not only for bacteria, as has already been widely established, but also for fungus. For this reason we maintain that this coating constitutes a valid opportunity in oncological resections for those patients who, being treated with chemotherapy, radiotherapy and to long hospitalitations present an elevated risk of fungal infection in oncological resections. From the studies we conducted it appeared how fundamental the use of silver in tumoural prosthesis is in order to prevent contamination by fungal strains and how this use must be taken more and more into consideration to improve life expectancy of a particular and sensitive category of patients, especially oncological.
TAPER LOCKING STRENGTH BY FOAM METAL COMPONENT
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Taper locking connection has been widely used in orthopedic implant devices. The long term successful clinical results indicated it is a safe and effective structural component. The common materials used are solid titanium and cobalt chromium alloys. Recently, foam metal materials showed promising results of bony in-growth characteristics and became the excellent choices for the orthopedic implants. Clinically it is desirable to taper lock the foam metal component to other structural components. To date there is no data for the foam metal being used directly in taper connection. The purpose of this study was to investigate the static locking strength of the taper junctions made of titanium foam metal comparing to that of conventional solid titanium material.

(5) 43mm long and 4mm thick sleeve were machined internally with 17mm major diameter and 3° included taper angle for each 70% porosity CP titanium foam metal and solid Ti6AL4VELI alloy materials. (10) Solid Ti6AL4VELI alloy stems were machined with OD geometry matching the ID of the sleeves. All components were inspected, cleaned and assembled to (5) pairs of each sleeve material combinations with 2224N axial compression force. Each assembled specimen was mounted on MTS Bionix test machine for torque resistance test. The angular displacement at 0.1 degree/sec was applied to the stem when sleeve was rotationally locked. The maximum torque resistance was recorded. The specimen was then re-assembled with 2224N axial compression force. Axial push out test was performed by loading at smaller end of the stem when the opposite end of sleeve was supported. The maximum push out force was recorded. Procedures were repeated for all foam metal and solid metal specimens. The taper interface surfaces were visually inspected to compare two types of sleeve materials.

The average torque resistance for foam metal and solid tapers were 20.4Nm (SD=3.68) and 21.7Nm (SD=3.72) respectively (p=0.59). The average axial locking forces were 2035.7N (SD=201.11) for foam metal taper and 1989.3N (SD= 451.84) for solid taper (p=0.839). There was no visual difference observed for tested stem outer and sleeve inner surfaces of foam metal and solid metal pairs.

This study suggested that the foam metal sleeve is capable to have comparable taper locking strength as the conventional solid taper components under dry static condition. The study indicated that the contact area does not significantly influence the friction locking. This is in agreement with the friction force definition which depends only on the coefficient of friction and normal contact force.
PATIENT-SPECIFIC 3-D BONE MODEL RECONSTRUCTION FROM X-RAY FLUOROSCOPY
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An accurate geometrical three-dimensional (3D) model of human bone is required in many medical procedures including Total Knee Arthroplasty (TKA) and computer-assisted surgical navigation. Segmentation of Computed Tomography (CT) datasets is commonly used to obtain such models. However, such a method is expensive and time consuming. We herein propose a novel method for patient specific bone model reconstruction using standard x-ray fluoroscopy, a cheaper and widely available imaging alternative.

Fluoroscopic images are taken at multiple arbitrary viewpoints to provide sufficient information for bone reconstruction. The viewpoints can be obtained by either rotating the imaging source and detector or the patient’s limb of interest. The bone’s pose within the radiological scene in each of the captured images can be estimated by tracking a set of metallic calibration markers within a calibration target, rigidly attached to the limb of interest. Having acquired the required calibration data, a complex iterative scheme is executed to optimize a statistical bone atlas of the bone of interest and the relative pose between the bone and the calibration target.

In order to verify our method, we performed a cadaveric study. A set of rigidly attached fiducial markers were attached to a cadaveric leg. The leg was imaged using x-ray fluoroscopy while being rotated axially to provide us with the images required for bone model reconstruction. Distal femur and proximal tibia bone models were reconstructed from the fluoroscopy images. Furthermore, the leg was CT-scanned and segmented to provide us with the ground-truth required for reconstruction accuracy assessment. Results show the adequacy of the proposed method for surgical applications.
DESIGNING BIOCOMPATIBILITY OF NANOSTRUCTURES FOR JOINT REPLACEMENT IMPLANTS  
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The steric and electrostatic complementarity of natural proteins and other macromolecules are a result of evolutionary processes. The role of such complementarity is well established in protein-protein interactions, accounting for the known protein complexes. To our knowledge, non-biological systems have not been a part of such evolutionary processes. Therefore, it is desirable to design and develop nonbiological surfaces, such as implant devices (e.g. bone growth for non-cemented fixation), that exhibit such complementarity effects with the natural proteins.

Cell attachment and spreading in vitro is generally mediated by adhesive proteins such as fibronectin and vitronectin [1]. The primary interaction between cells and adhesive proteins occurs through integrin and an RGD amino acid sequence. The adsorption of adhesive proteins plays an important role in cell adhesion and bone formation to an implant surface [1]. The ability of the implant surface to adsorb these proteins determines its aptitude to support cell adhesion and spreading and its biocompatibility. For example, the enhancement of osteoblast precursor attachment on hydroxyapatite (HA) as compared to titanium and stainless steel was related to increased fibronectin and vitronectin absorption [2].

The role of surface characteristics, such as topography, has been studied in recent years without the emergence of a comprehensive and consistent model [1]. For example, while no statistically significant influence of surface roughness on osteoblast proliferation and cell viability was detected in the study of metallic titanium surfaces [3], the TiO2 film enhances osteoblast adhesion, proliferation and differentiation upon an increase in roughness [4].

We designed and produced ceramic [5] and metallic coatings via an ion beam assisted deposition process with spatial dispersion (roughness) comparable to the size of proteins (3-20nm). Our ceramic and cobalt-chrome (CoCr) coatings exhibit high hardness and contact angles with serum of 0° and 40° to 50°, respectively. Furthermore, our theoretical calculations and quantum-mechanical modeling clearly indicate that the spatial electric potential variation across our designed ceramic surfaces is comparable to the electrostatic potential variation of proteins such as fibronectin, promoting increased absorption on these surfaces. Therefore, an increase in the concentration of adhesive proteins on the designed surfaces results in the enhancement of the focal adhesion of cells. Our experimental results of the adhesion and proliferation of osteoblast-like stromal cells from mouse bone marrow indicate that our nanostructured coatings are three to five times better than growing on HA and orthopaedic grades of titanium and CoCr. Our results are consistent with the steric and electrostatic complementarity of nanostructured surfaces and adhesive proteins. This paper presents the adhesion and proliferation of osteoblast-like cells on micro- and nanostructured surfaces and provides new models describing the mechanism responsible for the enhancement of cell adhesion on nanostructured ceramic and metallic surfaces compared with orthopaedic materials.

SURVIVORSHIP OF MONOBLOCK COBALT-CHROME ALLOY ACETABULAR COMPONENTS: FIVE TO TWELVE YEAR RESULTS
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Recently, monoblock cups have increased in popularity for hip resurfacing and large femoral head total hips. However, there have been no studies specifically evaluating the durability of this type of cup. The purpose of this study was to define the mid-term survivorship of cobalt-chrome alloy, monoblock acetabular components.

A retrospective radiographic review of 426 consecutive hip resurfacings using the Conserve®Plus prosthesis was performed with specific attention to the acetabular component. Radiographs were analyzed for cup position, the presence of radiolucencies, cup migration, bead shedding, osteolysis and stress remodeling of the pelvic bone. Kaplan-Meier (KM) survival estimates were calculated using revision for aseptic loosening of the acetabular component as the end point.

Average follow-up was 8.6 years (range 5.4 to 12.3). Mean abduction angle and anteversion angle were 46.6° (± 6.8°), and 21.6° (± 8.6°), respectively. Radiolucent gaps behind the cup from incomplete seating were visible in zone 2 in 16% of cases. These were typically 1 to 2 mm in size and radiographically filled in all but 2 cases. No cups with early lucencies went on to fail. Late radiolucencies developed in zone 1 in 8 cups (1.9%), in zone 2 in 8 cups (1.9%), and in zone 3 in 19 cups (4.5%). Radiolucencies in multiple zones were seen in 6 cups (1.4%). Small amounts of socket migration (2mm or less) were suspected in 3 cups (0.7%) but each of these has remained stable. There were no cases of bead shedding. Small osteolytic lesions were suspected in 12 hips (2.8%). There were 2 revisions for aseptic loosening of the cup at 5 and 8 years, and one revision for protrusion of the cup through the medial wall 4 days after surgery. Additionally, one cup at 9 years follow-up is believed to be loose but has yet to be revised. The KM survival estimate was 99.6% at 5 years (95% C.I. 98.4% to 99.9%) and 98.7% at 10 years (95% C.I. 94.5% to 99.7%).

In conclusion, this study demonstrates excellent mid-term survivorship of a cobalt-chrome alloy monoblock acetabular component, which matches that of conventional titanium implants. Small early gaps seen behind the cup from incomplete seating do not appear to effect cup survivorship as long as a good peripheral press-fit is obtained. Osteolysis with this prosthesis is rare but does occur.
At present, long-term follow-up studies are used to assess the performance and longevity of an implant, but the downside is that designers must wait 5-10 years before they receive this feedback. Therefore, the objective of this study was to develop a theoretical simulator that will allow for prediction of kinematic patterns based on implant shape and prediction of implant longevity based on the implant’s ability to adapt to in vivo conditions.

A model of the normal lower leg, including muscles and all ligament structures, was developed using Kane’s theory of dynamics. All muscles and ligaments were modeled as distributed loads and included wrapping points to follow the true path of soft-tissue structures. Currently, two activities are available to the user: leg extension and deep flexion. 3D shapes, pertaining to the implant designs are input to the model.

A validation of the model was conducted using an initial force prediction for each muscle. The predicted kinematics were compared to a library of in vivo kinematics from over 2000 knees obtained using fluoroscopy and a 3-D model fitting technique. If the kinematic patterns from the model were incorrect, an optimization feedback algorithm induced a change in the muscle force. This process continued until the proper muscle force profiles were determined. Then, using muscle forces which achieve observed motion in TKA previously implanted and analyzed, evaluation of various new implant designs could be assessed.

Altering designs or constraints in TKA lead to quite different kinematic profiles, even when the same muscle force profiles are used. Further research needs to be conducted using more design profiles before multiple implant designs could be evaluated and compared.
Pyrocarbon has been used for over 25 years in finger joint replacements. Excellent biocompatibility, material and wear properties make pyrocarbon ideal for an orthopaedic device. Pyrocarbon implants incur significantly less wear to articular cartilage than metal implants. The pyrocarbon implant replacement device (PIR) was developed to treat focal chondral and osteochondral defects of the femoral condyles. The PIR is intended to treat defects not amenable to microfracture or similar regenerative techniques and those for which unicompartmental or total knee arthroplasty is not yet indicated. The purpose of this study was to evaluate the in vivo articular response to the PIR device and compare it to a similar device made from cobalt-chromium (CoCr) device. In addition, bone fixation of the PIR device with and without hydroxyapatite (HA) coating was evaluated.

Nine adult bred-for-purpose beagles received bilateral 6mm medial condyle full thickness osteochondral defects. One defect was treated with a PIR device and the other an identical CoCr device. In addition, one HA-coated and one non-HA coated PIR device was placed unicortically in the lateral distal femurs of each animal. Three animals each were terminated at 12, 24, and 52 weeks postoperative. Non-decalcified histologic sections of the implanted condyles and calcified sections of the medial tibia and meniscus were evaluated. The femoral condyle sections were graded using a modified scale of Kirker-Head (2006). Additionally, the bone–implant contact area was quantified. The tibia-meniscus sections were evaluated utilising a modified version of the ICRS Histological Visual Scale (2002). The lateral distal femur implants were mechanically tested in axial push-out to compare the bone-implant interface strength between the HA-coated and non-HA coated PIR devices.

The mean histologic grades for the tibia and meniscus were superior for surfaces that articulated against the pyrocarbon PIR device compared to the CoCr device at 12, 24 and 52 weeks. Over time, the mean histologic grades decreased with both materials; however, tibias that articulated with the CoCr device had the lowest mean grade at 52 weeks. There were little difference in bone contact 12 and 24 weeks between the pyrocarbon and the CoCr devices. At 52 weeks, less bone contact was observed compared to 12 and 24 weeks. Mechanical testing demonstrated that the HA-coating imparted a statically significant improvement in interface strength as well as greater direct bone contact to the implant.

The results of this study confirm that pyrocarbon provides an ideal surface for an implant that articulates with cartilage of the knee. Although adequate direct bone contact was observed, the addition of HA-coating imparted both superior initial and long term bone fixation. The PIR device is suitable for restoration of focal defects of the knee.
KNEE CARTILAGE MOEDELING AND ITS EFFECT ON THE ACCURACY OF SURGICAL LANDMARKS IDENTIFICATION
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The success of TKAs depends on the restoration of correct knee alignment and proper implant sizing and placement. The mechanical axis is considered a key factor in the restoration of knee alignment along with the transepicondylar axis and the posterior condylar axis as references for external and internal implant rotation. Accurate calculation of the distal resection plane in the femur and proximal resection plane in the tibia is crucial to determine the amount of the bone to be resected. In this study, we developed a model for mapping the thickness of the femoral and tibial articulating cartilage. We also studied the effect of cartilage presence and the absence on the accuracy of calculating the surgical landmarks, implant sizing and placement.

Cartilage models were constructed using fat suppression MRI scans of healthy individuals with different body sizes. The femoral and tibial cartilages were segmented and surface models were generated. The inner and outer surfaces of the cartilage were separated, the inner surfaces were then mapped to the articulating surface of the femur and tibia to establish correspondence between the cortical bone surface and the inner surface of the cartilage. For each vertex on the normalized inner surface of the cartilage, the closest point was found on the outer surface of the cartilage and the normal distances were calculated. These distances were then averaged for each vertex across the population to calculate an average cartilage model. This average cartilage model was then used to grow a cartilage layer on our database of 300 bones from CT scans. Surgical landmarks and implant sizing and placement were then calculated for each bone before and after the cartilage and results were compared.

Some of the landmarks including the mechanical and transepicondylar axes were found to be independent from the presence or absence of knee articulating cartilage, whereas the posterior condylar axis and tibial and femoral resection planes can be affected by the absence or presence of cartilage.
GLOVE, GOWN AND DRAPE EFFECTS ON INTRAOPERATIVE BACTERIAL CONTAMINATION
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Perioperative infections can cause devastating results, especially in cases employing endoprostheses and/or allografts. To minimize bacterial contamination and thereby decrease infection rates, a series of experiments was performed to determine the role of several factors on intraoperative contamination.

In an initial pilot study, 102 surgical team members participating in clean orthopaedic cases were prospectively randomized to exchange or not exchange their outer pair of gloves one hour into the surgical procedures. Rodac plate cultures of the surgeon’s dominant gloved hand and of his or her gown sleeve were taken at baseline and again 15 minutes after potential glove exchange. The surgical gown type (reusable cloth versus disposable paper) utilized in each case was recorded. An unexpected overwhelming effect of gown type on bacterial contamination rates was detected, which overpowered any effect of glove exchange. The outer glove exchange experiment was then repeated with 251 prospectively randomized surgical team members, with all team members utilizing only disposable paper gowns. Otherwise the experimental protocol was the same. A final experiment was devised to test bacterial strike through of the two gown types. A standardized suspension (3 ml of coagulase negative staphylococcus containing 108 bacteria/ml) was applied to one side of the test materials and compressed with a 10 lb. weight. A rodac culture plate was applied to the opposite side of the material to determine bacterial strike through rates utilizing previously validated methodology.

The initial pilot experiment revealed a baseline sleeve culture positive rate of 41% with cloth gowns versus only 13% with disposable gowns (p=0.002, Students t-test). Cultures of the glove one hour and fifteen minutes into the operations revealed a 31% culture positive rate with reusable cloth gowns versus only 7% with disposable gowns (p=0.001), with a 4.38 x odds ratio. There was no statistically significant difference in the glove culture positive rate at one hour and fifteen minutes based on glove exchange (19% with glove retention vs. 10% following glove exchange p=0.19). There was no statistically significant difference in the culture positive rate between the two gown types when tested straight out of their sterile packaging (reusable gowns two positive cultures out of 50 cultures, disposable gowns zero positive cultures out of 50 cultures). On the second glove exchange experiment, surgeons exchanging gloves one hour into the case had a positive glove contamination rate of 13% compared to 23% in those retaining their original glove (p=0.04 Student’s t-test, odds ratio 0.51). The bacterial strike through study revealed that 22 of 25 cloth gowns allowed transmission of bacteria, whereas only 1 of 25 disposable paper gowns allowed transmission of bacteria (p=0.001, nonparametric sign rank test).

The choice of gown type had the greatest effect on the intraoperative culture positive rate of the surgeon’s dominant hand glove in our studies. Based on these results, at our institution, all orthopaedic surgeons now utilize only disposable paper gowns on all cases employing allograft or endoprosthesis implantation. We strongly recommend that only disposable paper gowns be utilized for any case with any orthopaedic implant materials and such gowns should be considered for all surgical cases. Exchange of the surgeon’s outer gloves prior to handling orthopaedic implant devices, especially if an hour of operating time has already elapsed, is also a recommended and prudent practice to diminish intraoperative contamination of the implant materials. The utilization of disposable drapes in addition to disposable gowns is also recommended due to the lower likelihood of bacterial strike through with currently available disposable synthetic materials. Following these recommended guidelines should help surgeons minimize the risk of intraoperative contamination and should thereby reduce the rate of infections.
MID-TERM CLINICAL OUTCOMES FOLLOWING PRIMARY TOTAL HIP ARTHROPLASTY WITH OXINIUM VERSUS COBALT CHROME FEMORAL HEADS. RESULTS OF A PROSPECTIVE RANDOMIZED TRIAL.
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Oxidized Zirconium (Oxinium, Smith & Nephew, Inc., Memphis, TN) is a relatively new material that features an oxidized ceramic surface chemically bonded to a tough metallic substrate. This material has demonstrated the reduced polyethylene wear characteristics of a ceramic, without the increased risk of implant fracture. The purpose of the current investigation was to assess clinical outcomes following primary total hip arthroplasty with Oxinium versus Cobalt Chrome femoral heads.

One hundred uncemented primary total hip arthroplasty procedures were prospectively performed in 100 patients. There were 52 males and 48 females with mean age at the time of surgery of 51 years (SD 11, range, 19-76). Using a process of sealed envelope randomization, patients were divided into 2 groups. Each group contained fifty patients. Those in group 1 received an Oxinium femoral head (OX), while those in group 2 a cobalt-chrome femoral head (CC).

The current study reports clinical outcome measures for both the OX and CC groups at a minimum follow-up of 2 years postoperatively. At the time of latest follow-up, stem survival for both groups was 98%. There was a significant improvement in all clinical outcome scores between preoperative and 2 year postoperative time periods for both bearing groups (p<0.003). There were no significant differences between bearing groups for any of the clinical outcome scores at final follow-up (p>0.159). Mean Harris Hip Scores at 2 years postoperatively were 92 and 92.5 for OX and CC, respectively (range; 65-100 OX, 60-100 CC). For SF-12, both the Physical Component Summary Scale (PCS) and the Mental Component Summary Scale (MCS) are reported. Mean PCS scores at final follow-up were 45.2 and 49.21 for OX and CC (range; 27.1-56.7 OX, 26.3-61.8 CC). Mean MCS scores were 53.8 and 52.57 for OX and CC (range; 39.2-65.5 OX, 34.3-64 CC). Mean final WOMAC scores are reported as 84.9 and 87 for OX and CC, respectively.

The current data suggest that total hip arthroplasty utilizing Oxinium femoral heads is safe and effective. Additional follow-up of the current cohort will be performed in order to fully assess mid- to long-term clinical outcomes.
IS THERE AN ASSOCIATION BETWEEN ARTICULAR CARTILAGE CHANGES AND TYPE OF MENISCAL TEAR?
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Purpose: The objective of the present study was to evaluate whether horizontal cleavage and complex meniscus tears, which supposed to be degenerative tears, are associated with an increase of specific matrix metalloproteinases and an increased incidence of cartilage damage, in comparison with patients having other patterns of meniscal injury1,2.

Materials and Methods: Data were collected prospectively from 32 knee arthroscopies, patients were assigned by intraoperative findings due to their meniscal tear to one of two groups: “degenerative meniscal lesions” (horizontal cleavage and complex tears; n=20) or “traumatic tears” (longitudinal and radial tears; n=12). Patient data (age, duration of symptoms, mechanism of injury, body mass index [BMI]), intra-articular and radiographic findings were recorded. Samples of knee joint fluid were analyzed for the matrix matrix metalloproteinases pro-MMP-1, MMP-3 and pro-MMP-13, which are postulated to be involved in articular cartilage degradation3. Cartilage changes were classified intraoperative by Outerbridge (grade 0-4). Praeoperative bone morphology of the knee joint was graduated by Kellgren-Lawrence (Stadium 0-4). The Knee Injury and Osteoarthritis Outcome Score (KOOS) was used to assess the patients opinion about their knee and associated symptoms and function preoperative and 1.5 years postoperative.

Results: Degenerative meniscus lesions appeared predominantly at the end of fifty years of age (58.5±13.9 years), whereas other patterns of meniscal lesions happened around 30 years of age (28.7±8.1 years; P< .0001; Fig. 1 [Median]). Patients with a degenerative meniscus lesion had marginally overweight, whereas patients with a traumatic tear were in the normal range regarding the body mass index (BMI 23.7±5.3 vs. BMI 26.8±3.9; P= .044). A comparison of patients with horizontal cleavage and complex meniscal tears (“degenerative tears”) to patients with longitudinal or radial (“traumatic”) tears showed for the former increased severity of chondral lesions (Outerbridge: 2.9±1.4 vs 1.1±0.9; P=. .001; Fig. 2 [Median]) and radiographic osteoarthritis (Kellgren-Lawrence: 1.9±1.5 vs 0.4±0.5; P=. .004; Fig. 3 [Median]). The KOOS improved after arthroscopic treatment in the degenerative-meniscal- tear group as well as in the traumatic-tear group significantly (Total-KOOS Score preoperative: 36.5±30.7 and 38.1±24.8; Total-KOOS Score 1.5 years postoperative: 87.8±6.7 and 49.2±21.9; p=. .043 and p= .012; “0” indicates extreme knee problems; “100” indicates no knee problems; Fig. 4 [Median]). Pro-MMP-13 correlated significantly with an increase of chondral lesions and radiographic osteoarthritis (r=. .534; p=. .003; r=. .457; p= .02). MMP-3 concentrations in the synovial fluid of patients with a degenerative meniscus lesion were about 20% higher compared to patients with other patterns of meniscal lesions. No one of the investigated MMPs correlated significantly with a specific meniscal injury (Fig. 5 [Median]).

Conclusions: Complex and horizontal cleavage meniscal tears are not as benign as was previously thought and are highly associated with an increased severity of cartilage degeneration and radiographic osteoarthritis. In spite of distinct cartilage changes arthroscopic treatment improved knee-related symptoms at least on medium-term also in patients with degenerative meniscal tears. In this study, increased concentrations of the investigated MMPs did not seem to be associated with specific patterns of meniscal lesions.

References:
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Development of artificial cartilage has been one of the future goals in the field of orthopaedic surgery. A few investigators have applied polyvinyl-alcohol hydrogel (single-network) to develop the artificial cartilage. However, it could not be applicable for clinical use due to insufficiency of the strength, the toughness, and the friction properties. The authors have conducted a fundamental study to apply a novel double-network (DN) hydrogel to develop the artificial cartilage. This hydrogel is composed of two independently crosslinked hydrophilic networks of poly-2-acrylamido-2-methylpropanesulfonic acid (PAMPS) and poly- N,N’-Dimetyl acrylamide (PDMAAm) that are physically entangled with each other. This study evaluated the in vivo influence of a PAMPS/PDMAAm DN hydrogel on counterface cartilage in rabbit knee joints and its ex-vivo frictional properties on normal cartilage. In the first experiment, the DN gel was implanted in a surgically created defect in the femoral trochlea of rabbit knee joints and the left knee was used as the control. Evaluations using a confocal laser scanning microscopy demonstrated that the DN gel did not affect the surface microstructure (surface roughness, the number of small pits) of the counterface cartilage in vivo at 4 and 12 weeks. The histology also showed the DN gel had no pathological damage on the cartilage matrices and cells at 4 weeks. However, 2 of the 5 DN gel-implanted knees showed mild irregularity on the counterface cartilage surface at 12 weeks. In the second experiment, the friction property between the normal and artificial cartilage was determined using a joint simulator apparatus. The ex-vivo mean friction coefficient of the DN gel to normal cartilage was 0.029, while that of the normal-to-normal cartilage articulation was 0.188. The coefficient of the DN gel-to-normal cartilage articulation was significantly lower that of the normal-to-normal cartilage articulation (p<0.0001). This study suggested that the PAMPS/PDMAAm DN gel has very low friction coefficient on normal cartilage and has no significant detrimental effects on counterface cartilage in vivo, and can be a promising material to develop the artificial cartilage.
USE OF COMPUTER-BASED TEMPLATING IN PREDICTING IMPINGEMENT OF TIBIAL STEM AUGMENTS IN KNEE ARTHROPLASTIES AFTER OPENING WEDGE OSTEOTOMY

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High tibial valgus osteotomy is now well established in management of medial knee osteoarthritis. While conventional closing osteotomies are usually within 2 cm of the knee joint, opening wedges typically pivot more distally from the joint line; theoretically the same angular correction will cause greater linear shift of the tibial plateau away from the tibial long axis. We hypothesise that this may lead to an increased incidence of problems with future knee replacement where tibial stem augments are needed, and to evaluate this we used a computer-based templating system with web-based component templates for sizing and implant position planning.

We studied 10 knees that had undergone opening wedge osteotomy. Pre-operative and postoperative mechanical and anatomical axes, and corrections achieved, were measured radiologically. Computer-based knee arthroplasty templating was then performed with the TraumaCad digital templating software (Orthocrat, Israel), using Depuy PFC tibial component templates with 75 mm stem augments. Cases were analysed for impingement of tibial stem augments when added to a well-placed tibial tray, and conversely for the need for tibial tray downsizing to avoid tray overhang if stem augments were placed centrally.

Results: Mean pre-operative mechanical axis was 10.6° varus (1.6° to 22.3°). Mean osteotomy to joint line distance was 25.7 mm (21.0 mm to 33.1 mm). In four knees, the addition of a 75 mm tibial stem augment to a well-placed tibial component caused stem impingement on cortex. In these four cases, central placement of the stem augment in the canal led to medialisation of the tibial component, necessitating downsizing of tibial tray by one to two sizes to avoid medial overhang and resulting in sub-optimal coverage of the cut tibia. These four cases all had valgus corrections of over 11° (11.5° to 19.6°). Conversely the six cases that did not have impingement or sizing problems all had corrections under 9° (3.0° to 8.2°). Our early results suggest that higher degrees of valgus correction with opening wedge osteotomy may lead to problems with future knee replacements requiring tibial stem augments. We are in the process of recruiting more cases to determine threshold levels for different makes and models of implants, using the same templating software system.
USE OF SLIDE PRESENTATION SOFTWARE AS A TOOL TO MEASURE HIP ARTHROPLASTY WEAR
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The authors propose a manual measurement method for wear in total hip arthroplasty (PowerPoint method, PP-method) based on the well-known PowerPoint software. In addition, the accuracy and reproducibility of the devised method were quantified and compared with two methods previously described by Livermore and Dorr, and accuracies were determined at different degrees of wear. The 57 hips recruited were allocated to; Class 1 (retrieval series), Class 2 (clinical series), and Class 3 (a repeat film analysis series). The PP method was found to have good reproducibility and to better detect wear differences between classes. The devised method can be easily used for recording wear at follow-up visits, and could be used as a supplementary method when computerized methods cannot be employed.

Key words: Total hip arthroplasty, Wear Measurement, PowerPoint method

Level of evidence: Diagnostic study, level –II
IN-VIVO LIKE TESTING OF CERAMIC BALL HEADS
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Ceramic hip components are known for their superior material properties concerning the in-vivo loading situation. In comparison to other commonly used materials, ceramics have a very low friction coefficient and a high fracture load. However, there are a few reported occasions of in-vivo fracture of ceramic ball heads.

An experimental set-up imitating the in-vivo loading situation is used to analyze different scenarios that may lead to the fracture of the ball heads, such as dynamic loading, edge loading and the metal taper condition. It will be shown that even the worst-case set-up does not lead to fracture loads if the interface between ceramic ball head and metal taper is clean and dry. In contrast, certain disturbances/impurities of this interface can cause a further reduction of the fracture load.

Ceramic ball heads made of pure alumina have been loaded until fracture under various conditions. The angle between the loading direction and the metal taper equals 35°, the ceramic ball is mounted in an alumina insert. Parameters under investigation were the inclination of the insert, the loading rate, and the condition of taper and ball head (contamination of the interface between taper and ball with adipose and osseous tissue; stripe wear on the outside of the ball head). Altogether 58 specimens (all alumina heads mounted on a titanium taper) have been tested. To resemble the position of the human acetabulum during walking and standing up, the inclination of the insert was chosen to differ between 45° (walking) and 80° (standing up). A variation of the loading speed is also tested, with a maximal speed in the range of the in-vivo loading rate (chosen parameters: 0.5 kN/sec and 25 kN/sec). For fabric samples, bovine femur (corticalis) and porcine adipose tissue were used.

All fractured ball heads were statistically analyzed regarding the appearance of fracture in general, the fracture origin, and the metal transfer in the cone of the ceramic ball head.

The behavior of the ball heads for the different scenarios shows a great variation: If the inclination of the insert equals 45°, it is not possible to break the ceramic ball head at all because of the high plastic deformation of the metal taper. In case of edge loading, the fracture load drops to 20 kN for 28-12/14 S ball heads and 36 kN for 28-12/14 L ball heads. The loading rate and the contamination of the interface between ball head and taper with adipose tissue have no measurable influence on this value.

The largest effect on the fracture load has a contamination with osseous tissue. The fracture load decreases to 32% compared to the value measured without the contamination. A minimal fracture load of approximately 8 kN (KK 28-12/14 L) was measured.

Statistical analysis shows that the fracture load depends linearly on the stiffness of the system (ball heads 28-12/14 S). Because none of the other parts changes during the experiments, the cause of the change in stiffness is most likely due to a change of the friction coefficient between ball head and taper: A reduced stiffness indicates a lower friction coefficient which results in higher normal forces in the ball head and, therefore, leads to lower fracture loads. This theory is supported by numerical calculations.

The influence of edge loading and contamination of the interface between taper and ball with osseous tissue on the fracture load can be shown. If the insert has a high inclination angle, high bending forces are applied to the ball head amplifying the effect of edge loading. It should be accentuated, that the minimum fracture load of a ball head without contamination of the interface is still twice as high as the maximum forces measured in-vivo.

Contamination with osseous tissue leads to a minimum fracture load of approximately eight times of the body weight, a value being close to the maximum forces ever measured in-vivo. Therefore, diligence is recommended during the implantation of the ceramic hip components in order to avoid disturbances of this interface. Because the reduction of the stiffness results in a reduction of the fracture load, the lubrication of the taper should be avoided.
WHAT IS AN ACCEPTABLE LEVEL OF METAL IONS AFTER METAL-ON-METAL HIP RESURFACING
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There have been many reports of metal ion levels measured in the bloodstream of patients after metal-on-metal hip replacement, and it is generally accepted that levels of cobalt (Co) and chromium (Cr) are elevated after these types of devices are implanted. However, it is not clear how to interpret these elevated levels; in particular what are the acceptable levels and what levels indicate that close monitoring of the patient is needed. Our aim was to establish the differences in metal ion levels between well functioning patients and those with clinical problems.

We measured serum Co and Cr levels (microgram’s per litre or μg/l) using inductively coupled plasma mass spectrometry with a well established collection protocol of all patients attending follow-up clinics. Our inclusion criteria for this study were all patients unilaterally implanted with a metal-on-metal hip resurfacing with no other metallic implant; patients were categorized as either A. Well Functioning or B. Clinically Problematic (pain, reduced function, reduced ROM, negative x-ray findings) and differences in ion levels between these two groups were examined. Well functioning patient data was only included if measurements were made more than 12 months post-operatively to avoid run-in wear levels. Abduction angle was also measured from x-rays of the pelvis, and the frontal plane coverage arc of each implanted cup calculated (De Haan JBJS[Br] 2008;90(10):1291-7). There were a total of 519 patients, with 358 in Group A and 161 in Group B; patients had a variety of devices with Birmingham Hip Resurfacing (64%) and Conserve Plus (29%) being the most commonly implanted. To establish a guideline upper ion level value for well functioning implants the upper 75th percentile values for Co and Cr levels for Group A patients having 15 mm or more coverage arc were calculated. The risk of having clinical problems was calculated as function of metal ion levels higher or lower than these upper limits.

The ion levels were significantly (Mann Whitney U p<0.001) higher in Group B (mean [95% confidence intervals], Co 10.2 μg/l [5.9 to 14.5], Cr 10.3 μg/l [6.7 to 14.0]) compared to Group A (Co 2.3 μg/l [1.7 to 2.4], Cr 2.8 μg/l [2.3 to 3.4]). The well functioning upper limit for Co was 4.1 μg/l and for Cr was 5.2 μg/l. Metal ion levels greater than these upper limits were significantly (Chi-square p<0.001) associated with the presence of clinical problems. The odds ratio for Co greater than 4.1 μg/l was 11.2 [95%CI 5.7 to 22.3] and that for Cr greater than 5.2 μg/l was 4.3 [95%CI 2.6 to 7.0].

There were significantly higher metal ion levels measured in patients with clinical problems after metal-on-metal hip resurfacing than those with well functioning hips. We have proposed upper acceptable limits for Co (4.1 μg/l) and Cr (5.2 μg/l) serum levels. Cobalt levels appear to be more reliable in predicting risk of clinical problems; levels greater than our proposed upper limit have 11 times the odds of developing clinical problems and patients with such levels should be followed closely.
**AUTOLOGOUS CHONDROCYTE IMPLANTATION IN THE ADOLESCENT KNEE**

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Autologous chondrocyte implantation (ACII) has been shown to have favourable results in the treatment of symptomatic chondral and osteochondral lesions. However, there are few reports on the outcomes of this technique in adolescents.

The aim was to assess functional outcome and pain relief in adolescents undergoing autologous chondrocyte implantation (ACI).

Thirty-one adolescent patients undergoing ACI or Matrix-assisted chondrocyte implantation (MACI) were identified from a larger prospective study. Mean age was 16.3 years (range 14 – 18) with a mean follow-up of 66.3 months (12-126 months). There were 22 males and nine females. All patients were symptomatic; 30 had isolated lesions and one had multiple lesions. Patients were assessed pre and postoperatively using the Visual Analogue Score (VAS), the Stanmore/Bentley Functional Rating Score and the Modified Cincinnati Rating System.

The mean VAS improved from 5.8 pre-operatively to 2 post-operatively. The Stanmore/Bentley Functional Rating Score improved from 2.9 to 0.9 whilst the Modified Cincinnati Rating System improved from 49.8 pre-operatively to 81.3 postoperatively with 87% of patients achieving excellent or good results. All postoperative scores exhibited statistically significant improvement from pre-operative scores.

The results show that, in this particular group of patients, this procedure produces reduction in pain and a statistically significant improvement in function post-operatively. We strongly recommend this procedure in the management of adolescents with symptomatic chondral defects.
EFFECT OF MAGNESIUM-FLUORIDE COATING ON THE DEGRADATION BEHAVIOR OF MAGNESIUM BASED IMPLANTS
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Degradable implants made of magnesium alloys as osteosynthesis material for weight-bearing bone are at present a main research area. With regards to biocompatibility, a MA with 0.8 wt. % Calcium (MgCa(0.8)) has been shown to possess advantageous qualities. Long-term investigations in animal models however, showed that the degradation rate of this magnesium alloy was relatively rapid and therefore the mechanical properties decreased early during the implantation period. An implant for osteosynthesis in weight-bearing bones however needs to exhibit adequate stability during the first few weeks of fracture healing. This cannot sufficiently be assured by the MgCa(0.8) alloy. It has been suggested in the literature, that the degradation rate of MA could be reduced using a fluoride coating. Therefore it was the aim of this study to investigate, whether the coating of degradable MA MgCa(0.8) implants with magnesium fluoride layer leads to decreased degradation rate and in consequence to an improvement of the mechanical properties using an animal model.

Extruded pins (2.5 mm x 25 mm) of MgCa(0.8) were produced. Twenty of these pins were coated with a fluoride layer by submerging the implants in a bath with 40% hydrofluoric acid. With this procedure, the pins were covered with a thin (150-200μm thickness) MgF2 layer. Coated and uncoated pins were intramedullary implanted into both tibiae of ten New Zealand White Rabbits. Three and six months after surgery five animals of each group were euthanized and the tibiae were explanted for further analysis. Micro-computed tomography (μCT) and scanning electron microscopy (SEM) were performed of the explanted pins. In order to investigate changes of the mechanical properties, 3-point bending tests were carried out with MgCa(0.8) pins at the initial state and with the explanted pins, with and without the fluoride layer at both times. In addition, the mass loss of the pins was determined. To evaluate the degradation process of the MgCa(0.8) pins with the MgF2 layer, micrographs and element analyses (EDX) were accomplished after the three point bending tests.

During the investigation period, the rabbits showed no signs of lameness or pain. The MgCa(0.8) alloy and the MgCa(0.8) alloy with the MgF2 layer showed significant differences regarding the mechanical properties in dependence of the implantation duration. Generally, the mechanical resistance decreases with increasing implantation time. The 3-point bending test showed, that the values of maximal force of the coated MgCa(0.8) implants after three month implantation duration were lower than those of the uncoated implants. After an implantation duration of six months, the values of maximal force of the implants coated with MgF2 were higher than those of the uncoated implants. Regarding the implant mass, the coated and uncoated MgCa(0.8) implants showed a loss of mass during the implantation period. The mass loss of the coated implants was only slightly lower. This difference was minor after three months and more obviously after six months. With μCT new endosteal bone formation could be seen close to all implants. A decrease of the cross section dimension could be demonstrated with μCT and SEM and changes of the surfaces due to pitting corrosion could be demonstrated in both the coated and uncoated MgCa(0.8) implants on the whole length, which was more obvious after six months. The micrographs showed corroded surfaces but not preferred corrosion on the grain boundaries. The element analysis showed a degradation layer on the implant surface, which was more bulky on implants after six month implantation duration. The mapping shows, that the fluoride molecules are clearly visible after three and six months around the margin of the implant.

With the results of this study it could be demonstrated, that the coating of the MgCa(0.8) implants with a fluoride layer did not have a positive influence on the mechanical properties and the degradation rate of the implant in the bone. This leads to the conclusion that MgF2-coated MgCa(0.8) implants are also not suitable for osteosynthesis in weightbearing bones.
ACCURACY OF CUP CENTER POSITION IN IMAGE-FREE NAVIGATION SYSTEM FOR DEVELOPMENTAL DYSPLASIA OF HIP
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Nowadays navigation system for THA is widespread and contributes to accurate cup installation as for cup abduction and anteversion angles. On the other hand, cup center position is very important to prevent leg length discrepancy and to acquire appropriate muscle tension especially for DDH cases. However planning and accuracy of cup center position was rarely mentioned when the efficacy of navigation systems were discussed. We therefore examined not only accuracy of cup angles, but also of cup center position in our image-free navigation system for DDH.

One hundred three THA operations were performed with using the image-free OrthoPilot hip navigation system (B. Braun Aesculap, Tuttlingen, Germany) between May 2006 and July 2008 by three experienced surgeons. In this system, we can measure the length between two different points marked by special pointer during surgery. Thus we pointed the upper rim of obturator foramen (this mark was estimated the lower tip of tear drop, and the bottom of reaming hole (this mark was estimated same height from cup center position) before cup installation and measured the vertical length between them(op length). After operation, we measured the vertical length from tear drop to cup center on the x-ray film (xp length), and compared these two values.

The average difference of two values were 6.41±4.17 mm ((op length)-(xp length)). Secondly we divided them into two groups, large error group (>0.7mm) and small error group (<0.6mm) and investigated the cause of large error. As result, large error was influenced by difference of surgeons, whereas not influenced by patient’s etiology and BMI.

By using image-free navigation system for DDH, we can plan the cup center position and install it within the error of 6.4mm. This will contribute to avoid a lot of hesitations during surgery. However surgeon’s skill and habitants have influence on this technique. We have to investigate this system and make effort to further improvement continuously.
Wear simulator studies suggest low wear rates of Alumina ceramic femoral heads with polyethylene total hip bearings. Short-term wear and clinical data of ceramic/highly crosslinked ultra-high molecular weight polyethylene (UHMWPE) couples are under reported in the literature. A retrospective review was performed to determine and compare the wear rate for hips implanted with an Alumina ceramic femoral head and X3® polyethylene insert to the acceptable polyethylene wear rate in the literature.

We evaluated 70 primary total hip replacements performed at one institution, by two surgeons, from February 2006 through June 2007. At a minimum 2 year follow-up, calculated annual wear for the ceramic/X3® polyethylene articulations showed a significant decrease compared to literature reports of 0.1 mm/year or greater for conventional polyethylene.

Radiographic and clinical outcomes show no loose implants, dislocations, ceramic fractures or revision surgeries at last follow-up. These early findings suggest that ceramic/X3® bearing couples may serve as an acceptable choice for the younger, active patient.
DOES A DYSPLASTIC HIP REPLACEMENT REQUIRE A STEM WITH REDUCED (COXA VALGA) MEDIAL CURVE WHEN A PHYSIOLOGICAL PROXIMAL LOAD TRANSFER IS EXPECTED?


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Introduction: For longer lasting and bone conserving cementless stem fixation, stable and physiological proximal load transfer from the stem to the canal should be one of the most essential factors. According to this understanding, we have been developing a custom stem system with lateral flare and an off-the-shelf (OTS) lateral flare stem system was added to the series. On the other hand, dysplastic hips are often understood that they have larger neck shaft angle as well as larger anteversion. In other words they are in the status called “coxa valga.” From this point of view we had been mainly using custom stems for the dysplastic cases before. After off-the-shelf lateral flare stem system; which is designed to have very high proximal fit and fill to normal femora; was added, we have been using 3D preoperative planning system to determine custom or OTS. Then in most of the cases, OTS stem were suitably selected. Our pilot study of virtual insertion of OTS lateral flare stem into 38 dysplastic femora has shown very tight fit in all 38 cases. The reason was analyzed that the excessive anteversion is twist of proximal part over the distal part and the proximal part has almost normal geometry. In the present study, 59 femora were examined by the 3D preoperative planning system how the excessive anteversion effect to the coxa valga status.

Materials and Methods: Fifty-nine femoral geometry data were examined by the 3D preoperative planning system. Thirty-three hip arthritis, 3 RA, 2 metastatic bone tumours, 5 AVN, 1 knee arthritis, 12 injuries, and 3 normal candidates were included. Among them one arthritic Caucasian and one AVN South American were included. The direction of the femoral landmarks; centre of femoral head (CFH), lesser trochanter (LTR), and asperas in 3 levels (just below LTR, upper 1/3, mid femur; A1-3); were assessed as the angle from knee posterior condylar (PC) line. Neck shaft angle of each case was assessed from the view perpendicular to PC line and neck shaft angle form the view perpendicular to CFH and femoral shaft (i.e. actual neck shaft angle).

Results: Average anteversion was 34.4 +/- 9.9 degree. CFH and LTR correlated well (i.e. they rotate together). A1, A2, A3 correlated well (i.e. they rotate together). LTR and A1 correlate just a little, LTR and A2 were independent each other. So the twist existed around A1. Neck shaft angle was 138.7+/- 6.6 in PC line view and in actual view 130.3+/- 4.4. No excessive neck shaft angle was observed in actual view. Even the case that has the largest actual neck shaft angle (140.4), the virtual insertion showed good fit and fill with the lateral flare stem.

Conclusion: In many high anteversion cases, coxa valga is a product of the observation from non perpendicular direction to CFH-shaft plane. Selection or designation of the stem for high anteversion cases should be carefully determined by 3D observation.
THE RATIONALE AND VALIDATION OF AN AUTOMATED WEB-BASED ELECTRONIC DATA CAPTURE RADIOGRAPHIC MEASUREMENT TOOL

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The trend toward evidence-based decision-making in orthopedics requires the analysis of large sets of data in real time that can direct clinical decision-making. We have developed an automated web-based electronic data capture (EDC) software system designed to simplify and make more time and cost efficient orthopedic data collection and analysis. The purpose of this study is to validate the radiographic alignment tool of the EDC software system. The goal was to establish the feasibility of using this web-based EDC tool in clinical practice.

Twenty-eight consecutive unilateral TKAs were performed on 28 patients. Coronal mechanical axis and sagittal tibial and femoral axis radiographic measurements were obtained preoperatively and 1 month postoperatively. The radiographs were uploaded to a web-based EDC knee surgery data analysis program that includes a radiographic measurement tool. Two blinded observers analyzed the radiographs; one using a conventional manual measurement tool and the other a web based measurement tool. A paired t-test was used to evaluate measurement variation between observers.

There was no statistically significant difference in preoperative mechanical axis (.18°, p>.05), postoperative mechanical axis (.25°, p>.05), postoperative femoral component axis (.68°, p>.05), and postoperative tibial component axis (1.07°, p>.05) measurements performed using the manual tool and the web-based software systems.

The results of this study validate the ability of the web-based software system to collect and process radiographic measurements. An automated web-based EDC software system allows for the full integration of patient demographic, radiographic, and peri-operative clinical variables in a fully searchable, instantaneously updatable and easily analyzed database. It is anticipated that this unique approach will allow surgeons to gather a wealth of searchable and quantifiable data that can quickly, accurately, economically, and efficiently shape clinical decisions.
REAL TIME MONITORING OF PROGRESSIVE DAMAGE DURING LOADING OF A SIMPLIFIED TOTAL HIP STEM CONSTRUCT USING EMBEDDED ACOUSTIC EMISSION SENSORS

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The Acoustic Emission (AE) technique has been described as possessing 'many of the qualities of an ideal damage-monitoring technique', and the technique has been used successfully in recent years to aid understanding of failure mechanisms and damage accumulation in bone cement during de-bonding of the cement-metal interface fatigue loading, pre-load cracking during polymerisation and to describe and locate damage within an entire stem construct. However, most investigations to date have been restricted to in-vitro testing using surface mounted sensors. Since acoustic signals are attenuated as they travel through a material and across interfaces, it is arguable that mounting the sensors on the bone surface to investigate damage mechanisms occurring within the bone cement layer is not ideal. However, since direct access to the bone cement layer is not readily available, the bone surface is often the only practical option for sensor positioning.

This study has investigated the potential for directly embedding AE sensors within the femoral stem itself. This enables a permanent bond between the sensor and structure of interest, allows closer proximity of the sensor to the region of interest, and eliminates potential complications and variability associated with fixing the sensor to the sample. Data is collected during in-vitro testing of nominal implanted constructs, and information from both embedded and externally mounted AE sensors are compared and corroborated by micro-Computed Tomography (micro-CT) images taken both before and after testing.

The use of multiple AE sensors permitted the location as well as the chronology of damage events to be obtained in real time and analysed without the need for test interruption or serial sectioning of the test samples. Parametric analysis of the AE signal characteristics enabled those events likely to be associated with cracking as opposed to interfacial rubbing or de-bonding to be differentiated and it was shown that the embedded sensors gave a closer corroboration to observed damage using micro-CT and were less affected by unwanted sources of noise.

The results of this study have significant implications for the use of AE in assessing the state of total hip replacement (THR) constructs both in-vitro and potentially in-vivo. Incorporating the sensors into the femoral stem during in-vitro testing allows for greater repeatability between tests since the sensors themselves do not need to be removed and re-attached to the specimen. To date, all in-vivo studies attempting to use the AE technique to monitor the condition of any replacement arthroplasty device have used externally mounted sensors and suffered from the attenuation of acoustic information through flesh and skin. It is hypothesised that the use of directly embedded AE sensors may provide the first steps towards an in-vivo, cost effective, user friendly, non-destructive system capable of continuously monitoring the condition of the implanted construct and locating the earliest incidences of damage initiation.
NEW BEARING TECHNOLOGY FOR HIP RESURFACING
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Although metal-on-metal hip resurfacing (MOMHR) is becoming a well accepted indication for young active patients with hip deformities, it does not come without its disadvantages. Longterm bone atrophy, serum metal ion elevation, metal ion hypersensitivity and the formation of pseudotumours have all been reported in the literature. It is thus clear that there is a need for novel bearing technology.

A potentially revolutionary hip resurfacing system comes in the form of the TriboFit® Hip System, which comprises a 2.7 mm-thick acetabular buffer made of polycarbonate-urethane, a hydrophilic, biocompatible, endotoxin-resistant material which mimics the fluid film layer naturally present in hip joints. This is a pliable implant whose modulus of elasticity is the same as that of normal human cartilage, thus providing optimum shock absorption. In addition, it induces lubrication, which is of the utmost importance as friction is almost eliminated, resulting in a subsequent decrease in the production of wear particles. Indeed, in vitro studies have shown that metal wear is 7-fold less than with a comparable metal-on-metal implant.

The TriboFit® Buffer is implanted using flexible mechanical fixation. With a special instrument, a circumferential groove is cut into the patients’ socket. The TriboFit® Buffer is seated by applying gentle pressure, with its ledge snapping tightly into the groove. The surgical technique is bone sparing as no acetabular bone reaming is required whatsoever. The TriboFit® Buffer can be coupled with a select number of metal hip resurfacing femoral components.

In our centre, we have used this novel bearing technology to treat patients with both osteoarthritis (two patients) and avascular necrosis (four patients). The mean patient age was 50 years (range 30 to 63). In five patients who had a well preserved socket anatomy, the TriboFit® Buffer was implanted without reaming the acetabular bone. In one patient with significant osteoarthritic changes of the socket, the TriboFit® Buffer was inserted into a specially manufactured uncemented metal shell, using the TriboFit® Buffer as a liner. The socket was reamed according to the standard reaming technique. In two patients a Birmingham hip resurfacing (BHR) femoral component was used and in the other four an ADEPT component was used.

Rehabilitation was fast and uncomplicated. The mean follow-up of these patients was one year. The mean preoperative Harris hip score (HHS) was 62. The mean HHS at one year was 99 (p = < 0.05). X-rays showed good quality bone at the bone-implant interface. No osteolysis, loosening, or bone rarefaction was observed. At follow-up, two patients resumed sporting activities. One patient resumed skiing while the other resumed biking.

Our pilot study shows that TriboFit® Buffer hip resurfacing arthroplasty is a valid alternative to MOMHR. Compared to the latter, the major advantage includes significantly lower metal wear generation, without any differences in the functional results. This new technology has the potential to expand the use of hip resurfacing to patients with renal malfunction, metal ion allergy/hypersensitivity and to fertile females.
ACCELERATED AGING OF NEXT GENERATION CROSS-LINKED MATERIALS: STABILITY CONCERNS?
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Irradiation cross-linking of UHMWPE has been shown to reduce wear while generating free radicals that oxidise in the presence of oxygen or oxidising species. Various methods have been used to minimise or eliminate the effect of these free radicals including below-melt annealing, remelting, Vitamin E infusion, or the use of other antioxidants. Each method has benefits and drawbacks with respect to wear properties, mechanical properties, and chemical properties. Accelerated aging techniques are used to evaluate the efficacy of new methods in stabilising free radicals in highly cross-linked UHMWPE.

Various procedures have been described for aging standard gamma-air sterilised UHMWPE to produce oxidation levels that represent shelf-aged bearings. An important factor in evaluating and comparing these aging techniques is validating that they reproduce the profile of oxidation (depth and magnitude) seen both in gamma-air, shelfaged polyethylene and in clinical retrievals. Moreover, the resulting oxidation level in the aged UHMWPE should predict the fatigue and/or wear damage seen in retrieved gamma-air inserts and liners.

The present study compared clinically relevant UHMWPE samples aged with ASTM 2003-00, (Method B: 70°C, 5 atm O2, 14 days) and a published lower temperature, lower oxygen-pressure environment (63°C, 3 atm O2, 28 days). Longer aging times (35 to 42 days) were also tested to examine oxidation rate and time to onset of mechanical degradation.

Both published methods result in oxidation of gamma-air and gamma-barrier sterilised polyethylene, but have little effect on remelted or antioxidant stabilised crosslinked polyethylene. These aging protocols, however, did not bring standard polyethylene to the critical oxidation level necessary for the fatigue damage that is seen in retrieved inserts and liners.

Oxidation of gamma-air and gamma-barrier sterilised UHMWPE increases exponentially with time on the shelf or in the two aging environments. Of note, longer aging times (35 to 42 days) that bring standard UHMWPE to sufficiently high oxidation levels for fatigue to occur also cause increased oxidation levels in remelted UHMWPE. Oxidation increases were the smallest in antioxidant UHMWPE, though still detectable. While this oxidation is not high enough in remelted material or antioxidant material to cause the fatigue damage seen in gamma-air sterilised UHMWPE, it does raise concerns about the published aging protocols and the long term stability of the new materials in vivo.

Relying on artificial aging techniques that do not adequately challenge even gamma-air polyethylene may conceal unforeseen weaknesses of new materials. Using longer aging times for existing techniques or novel aging approaches may be necessary to effectively evaluate the long term stability of new bearing materials.
HOW DURABLE ARE TITANIUM NITRIDE COATINGS ON TOTAL HIP REPLACEMENTS?
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To eliminate UHMWPE debris, hard-on-hard bearing surfaces are regaining favor, and metal-on-metal (MOM) is one such combination. To further improve the performance of MOM THRs, a titanium nitride (TiN) coating is sometimes applied through pressure vapor deposition to femoral heads and acetabular liners. This coating has sufficient hardness and therefore may resist abrasion and reduce overall wear, or at least not prohibitively compromise them. One such coating applied commercially was tested on a hip simulator, with coated and uncoated (control) implants supplied by the same implant manufacturer. This study investigates the wear rates of MOM THRs with and without the TiN coating over a 5 million cycle (Mc) in vitro wear test.

Six MOM THRs with 44mm diameter CoCr femoral heads, acetabular liners, and acetabular shells were simultaneously tested on a hip simulator (AMTI, Boston). Three of the six had heads and liners coated in TiN, and the remaining three were uncoated for control. The specimens were mounted anatomically and were lubricated with bovine serum diluted with deionized water to have 20g/l protein concentration at 37°C. The THR specimens were subjected to the loading and rotations of the walking cycle in ISO-14242-1 at 1Hz for 5Mc, without distraction. The loading and rotations were continually observed to ensure consistency with the desired waveforms. The femoral heads and acetabular liners were carefully cleansed and gravimetrically weighed at standard intervals.

Over 5Mc, the uncoated heads displayed a wear rate of 1.84±0.18mg/Mc while the coated femoral heads wore at 4.37±2.01mg/Mc. Wear results were similar in the case of the uncoated and coated metal acetabular liners (1.35±0.11mg/Mc and 4.16±2.06mg/Mc, respectively). However, most interesting was the observation that all three TiN coated THR specimens displayed a loss of coating on both the head and liner in the articulating region. The area where the coating wore away increased in size as the test progressed. The higher wear observed on the coated specimens was due to the removal of the coating, and perhaps the coating particles causing third body wear (evidenced by numerous scratches on coated components). The loss of coating occurred early in the experiment (after only 0.25Mc) in the case of one specimen which caused severe scratching and high wear to that specimen. After this “breakaway wear” occurred, the wear on that specimen stabilized. The difference in wear between the coated and uncoated femoral heads was not statistically significant. The difference in wear between the two types of metal acetabular liners was not statistically significant until 3Mc, after which it became marginally significant (p<0.05).

Our simulator results confirm small wear overall for MOM THRs, however, we did find extreme “run-in” wear on one TiN coated specimen. The eventual loss of the TiN coating on all three coated specimens is of concern, as this coating is marketed commercially in some parts of the world. It is possible that the coating process was conducted improperly, which resulted in poor adhesion to the substrate, or perhaps resulted in thin application/deposition in the area where the coating did not last.
EVALUATION OF INTRAOPERATIVE PELVIC POSITION DURING HIP ARTHROPLASTY USING COMPUTED TOMOGRAPHY/RADIOGRAPHY MATCHING

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INTRODUCTION: Malposition of the pelvis at the time of acetabular component insertion can contribute to malpositioning of the acetabular component. This study measures the variation in intraoperative positioning of the pelvis on the operating table during surgery by matching intraoperative radiographs with pre-operative computed tomograms (CT) using 2D-3D matching.

METHODS: This prospective study was comprised of a random sample of 45 patients (n = 45, 26 female, 19 male) who had received a total hip arthroplasty (THA) from a single surgeon from 10/21/2003 to 9/6/2007. No THA candidate was excluded for any reason, including body habitus (mean BMI = 27.7, range 17.5 – 42.3), underlying disease process, age (mean age at surgery = 57, range 27 – 80), sex or side of surgery (21 left THAs, 24 right THAs). According to our standard clinical treatment protocol, each patient had a pre-operative CT scan for CT-based surgical navigation of the hip arthroplasty and each patient had an intraoperative radiograph taken to assess component positioning. All THAs were performed in the lateral decubitus position on a radiolucent peg-board positioning device. Each patient's intraoperative pelvic radiograph was taken after acetabular component and trial femoral component insertion with the leg placed in a neutral position on the operating table and with the x-ray plate aligned squarely with the operating table. The orientation of the pelvis on the operating table was calculated by comparing the intraoperative 2D projection to the 3D CT dataset using software that can perform 2D-3D matching (XAlign). This software has been validated previously. By matching the 3D CT dataset to the magnification and orientation of the plain radiograph, the position of the anterior pelvic plane relative to the operating table could be calculated.

RESULTS: The mean pelvic tilt (rotation around the medial-lateral axis) was 6.84 degrees of anterior pelvic tilt (lordosis) with a standard deviation of 7.95 degrees and a range from 27.24 degrees of lordosis to 4.96 degrees of kyphosis. The mean pelvic obliquity (rotation around the longitudinal axis) was 2.89 degrees anterior from neutral with a standard deviation of 9.44 degrees and a range from 29.36 anterior to 16.59 posterior from neutral. The mean pelvic rotation (rotation around the anterior-posterior axis) was 2.56 degrees cephelad, with a standard deviation of 4.10 degrees and a range from 10.88 degrees cephelad to 5.97 degrees caudad. Pearson correlation statistics showed no relation among pelvic position and body mass index or age. A correlation was seen between pelvic obliquity and pelvic rotation.

CONCLUSION: This study shows a high variability of intraoperative pelvic positioning in the clinical setting using accurate measurement tools. The greatest variation was seen in pelvic obliquity which has the greatest influence on anteverision/retroversion of the acetabular component. Additionally, pelvic obliquity and rotation appear related in our series. Since all of our intraoperative radiographs were taken with the leg in a neutral position, it is likely that the pelvis is even more greatly malpositioned at other times during the surgery when forces applied by retractors or upon the leg may be greater.
MEASUREMENT OF THE CANAL FLARE INDEX USING 3-D MODELS AND THE EFFECT OF THE ROTATIONAL FEMUR POSITION

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Canal Flare Index, defined as the ratio of the intracortical width of the femur at a point 20mm proximal to the lesser trochanter and at the canal isthmus by Noble et al., is considered to express the proximal femoral geometry, but it is usually measured by a plain A-P X-ray. Then it is thought the index is influenced by rotational position of the femur, so we made 3-D femoral model based on CAT scans and measured the canal flare index three dimensionally. Then the effect of observation from rotated direction was evaluated.

CAT scans of 49 femurs (18 male, 31 female) were obtained from the pelvis to the feet. The average age was 60.4 years old ranging from 25 to 82. Forty nine femurs contained 22 osteoarthritis of hip joint, 12 trauma, 9 knee arthritis, 3 avascular necrosis of femoral head, 3 normal candeates. From those data, 3-D models of normal side were individually made for measuring the parameters. 3-D models were made using CAD software. We measured the canal flare index at which the femur posterior condyles were parallel to the plane, reproducing the situation to take A-P X-ray. After that, those 3-D models were rotated and investigated the difference of the value to study the effect of femur position.

The canal flare index was between 2.8 and 6.6 with the average value at 4.65. The stovepipe (canal flare index < 3), the normal range (3 canal flare index < 4.7), the champagne flute (4.7 canal flare index), included 2%(1 femur), 61.2%(30 femurs), 36.7%(18 femurs), respectively. About the effect of rotation, we found the value of canal flare index was more sensitive to proximal femur rotation than the canal isthmus. The results of the canal flare index at the plane parallel to the posterior condyle line varied widely compared with the results at the position considering the anteversion. So it was suggested that the canal flare index at the patella front position does not represent the canal characteristics. It should be argued in 3-D space.
MOTION TRACKING USING MINIATURE WIRELESS MEMS INERTIAL MOTION SENSING UNIT
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Body motion tracking for kinematic study is typically done with optical sensors. The user wears markers and the cameras track them to compute the transformation of the motion frame by frame. This method requires a set up of multiple motion capturing cameras and it can only be done within the specific area. The goal of this project is to create a tracking unit that does not require expensive overhead and can be done in any location.

The advancement in micro-machined microelectromechanical system (MEMS) sensors such as accelerometer, gyroscope and magnetometers can be used for human motion tracking. The unit is attached to a body segment or an external housing unit such as a knee brace. The orientation of the unit can be calculated based on the data from all 3 of the sensors. A complementary filter is used to fuse the data together to generate a single Euler angle matrix. Relative motion between the joint can be calculated from the output of 2 of the measuring units.

The sensors are calibrated with an average static orientation error of +/- 0.7 degree and standard deviation of 1.8 degrees. The dynamic orientation error of rotating around a single axis is 2.38, 0.15 and 0.517 degrees with standard deviation of 0.99, 0.98 and 0.7 degree for roll, pitch and yaw respectively.

The initial design shows good result for human body motion tracking. The performance of the unit can be further improved with optimizing the filter and using the data from different type of the sensors to compensate each other.
A DUAL MOBILITY CERAMIC-ON-CERAMIC JOINT IN THA A NEW SOLUTION TO REDUCE THE RISK OF DISLOCATION OR SUBLUXATION

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Dislocation remains one of the most common complications after total hip arthroplasty. Precise cup position appears to be a main factor as significant variations occur for frontal and sagittal acetabular tilt and anteversion according to sitting or standing positions. An innovative dual mobility ceramic-on-ceramic joint has been developed to solve these problems.

The dual mobility ceramic-on-ceramic joint allows to move the rotation center much deeper inside the insert in order to increase the joint stability without negative impact on the ROM. This device revealed higher torques against subluxation in comparison to the classical Al-Al systems, even with 36mm head diameters, or 41 mm metal on metal bearings. The additional outer-bearing surface motion creates a second "adjustable acetabulum" due to the eccentrication between the rotation center of the ball head and the rotation center of the bipolar head. This offset creates a resultant force that rotates the bipolar component. Using two bearing ceramic surfaces, the intermediate component acts as a “self adjusting cup”, dealing with the variations of pelvic orientation and acetabulum anteversion.

The use of the dual mobility ceramic-on-ceramic joint seems an interesting alternative when facing difficult or unexpected situations for cup adjustment and cases with hip instability.

In a hip simulator in micro separation condition, the wear of the dual mobility ceramic-on-ceramic was less than 0.01 mm³/ million cycles, the detection limit for wear measurement. There was no change in the surface roughness of the inserts. The design of the joint with the mobile ceramic head prevented edge loading of the head on the edge of the cup. No stripe wear was observed.

Since 2006 more than 2000 dual mobility ceramic-on-ceramic systems have been implanted in Europe and clinical studies are conducted. The aim is to demonstrate the resistance to dislocation in primary total hip arthroplasty. Previous results over 125 patients in a prospective multicentric study show a Harris and Womac score equivalent to a standard hip prosthesis. No dislocations have been reported. No ceramic breakage or “squeaking” phenomenon appears.

Dislocation and microseparation are major causes of failure for ceramic-ceramic hip prosthesis. When no ideal solution has been found for acetabular implantation, the dual mobility ceramic-on-ceramic device is a real alternative. The exclusive design of the bipolar head give the high resistance to wear and stripe wear to the dual mobility ceramic-on-ceramic joint. Reducing the risk of dislocation and reducing wear drastically are two advantages that can place the dual mobility ceramic-on-ceramic joint as the best choice in primary Total Hip Arthroplasty. Obviously this choice applies to recurrent dislocation also.
WIRELESS GROUND REACTION FORCES AND LOCATIONS ACROSS THE FOOT USING IN-SHOE MEMS PRESSURE SENSORS

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Force profiles across the foot yield information on abnormal kinematics and may be used to indicate pathological changes in the lower limb. However, current technology is limited to tethered systems using wired sensors. This paper outlines a wireless prototype that allows force profile measurement and through an in-shoe monitoring device utilizing custom high-accuracy sensors.

Direct measurement of the ground reaction force using a force plate is common practice for use in kinematic studies and is used as an input for mathematical models to predict forces across joints of interest during various activities. Force plates are reasonably accurate but are bulky and only allow one net force measurement at a single location and are not portable. Thus natural patient motion may be modified, intentionally or unintentionally, in order for heelstrike to occur on the force plate. In addition to force magnitude, it is useful to record force location to correlate with kinematics; abnormal kinematics will cause weight-bearing forces to shift across the foot. Current in-shoe pressure measurement devices on the market are plagued by errors up to 30% and require a cumbersome cable out of the shoe to read sensor data. By eliminating all wires, our device enables in-shoe monitoring in a research or clinical environment.

The device uses microelectromechanical system (MEMS) capacitive pressure sensors fabricated in a flexible array that attaches to a shoe insole or orthotic. The sensors are concentrated at the heel and forefoot in the prototype design and they exhibit a highly linear response to loading, eliminating the need for constant recalibration. Electronics embedded in the shoe read the entire array of 256 sensors at a rate of 60 Hz. The data is transmitted via Bluetooth at 2.4 GHz to the receiving computer for visualization and analysis. The paper assesses current technology in in-shoe sensing, outlines the device design, and reports initial stages of testing.

The prototype developed in this study shows promise for wireless monitoring of ground reaction forces for biomechanics analysis without restricting activity or impeding natural motion.
LATERAL EPICONDYLAR OSTEOTOMY USING COMPUTER NAVIGATION IN TOTAL KNEE ARTHROPLASTY FOR RIGID VALGUS DEFORMITIES
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Extensive release of postero-lateral structures may be required to correct rigid and severe valgus deformities during total knee arthroplasty. Current techniques are technically difficult, may not accurately restore soft tissue balance, and are associated with postoperative complications. We evaluated the results of using computer navigation for lateral epicondylar osteotomy during total knee arthroplasty for rigid severe valgus arthritis.

We had performed this procedure during navigated TKA in 10 valgus arthritic knees (2 bilateral TKAs) in 8 patients (1 male and 7 female). The mean age at the time of surgery was 65.7 years (range, 48-77 years) and the mean preoperative valgus deformity was 19.25° (range, 10° - 36.5°). The mean postoperative limb alignment at the end of a mean follow-up of 20 months (range, 14-31 months) was 0.5° valgus (range, 2° varus-1.8° valgus). None of the patients had any complications related to the procedure with no obvious clinical mediolateral instability and complete union at the osteotomy site was noted in all patients radiographically at the last followup.

Computer navigation allows for precisely measuring the difference between medial and lateral gaps as well as the limb alignment and to determine the effect of sequential soft-tissue releases on both. Our technique takes advantage of this feature to accurately re-position the lateral epicondylar block in order to equalize medial and lateral gaps thereby ensuring a stable knee. Internal fixation with compression screws coupled with large contact surfaces of cancellous bone at the osteotomy site allow for early post-operative rehabilitation and ensure union at the osteotomy site.