

**DIVISION OF ORTHOPAEDIC SURGERY  
UNIVERSITY OF OTTAWA**

***H. K. UHTHOFF ANNUAL RESEARCH DAY***

**THURSDAY, APRIL 30, 2015**

**UNIVERSITY OF OTTAWA  
ROGER GUINDON HALL, AMPHITHEATRE B**

**VISITING PROFESSOR**

***Ginger E. Holt, MD  
Professor and Vice Chair, Department of Orthopaedic Surgery  
Vanderbilt Medical Center  
Nashville, Tennessee***



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**UNIVERSITY OF OTTAWA  
ORTHOPAEDIC SURGERY**

We are pleased to welcome

***Ginger E. Holt, MD***

as the 2015 H. K. Uthoff Visiting Professor

**Dr. Holt completed an orthopaedic surgery residency at Vanderbilt Medical Center followed by a fellowship in Musculoskeletal Oncology in Toronto, Ontario and an Adult Reconstruction fellowship in Denver, Colorado.**

**Dr. Holt has been on faculty at Vanderbilt Medical Center for 12 years and is Professor and Vice Chair in the Department of Orthopaedic Surgery. Dr. Holt has a clinical focus on sarcoma surgery and limb salvage in the adult and pediatric population.**

**Dr. Holt is the Orthopaedic Surgery Residency Program Director and has served on the faculty of the Miller Review course for five years and was an AOA ABC traveling fellow in 2011. Dr. Holt is a proud Can-American traveling to Canada as much as possible.**

**RESIDENT RESEARCH REQUIREMENTS  
THE DIVISION OF ORTHOPAEDIC SURGERY  
UNIVERSITY OF OTTAWA**

- 1. All residents must participate in a minimum of two research projects during their residency.**
- 2. Research plan and protocol is presented to the Research Visiting Professor in November.**
- 3. Preliminary results are presented to the Division of Orthopedic Surgery Research Committee in early April.**
- 4. The final paper is presented at the H.K. Uthoff Research Day in April.**
- 5. Papers are chosen for submission to Collins Day in May.**
- 6. Two completed manuscripts must be written in style of the Journal of Bone and Joint Surgery and submitted to the Chairman of the Resident Research Committee, one by the end of the PGY-3 year and one by the end of the PGY-4 year.**

**RESIDENTS/FELLOWS**

**DIVISION OF ORTHOPAEDIC SURGERY**

**2014-2015**

**PGY-5**

**Dr. Gillian Bayley  
Dr. Kelly Hynes  
Dr. Matthew MacEwan  
Dr. Ian MacNiven  
Dr. Travis Marion  
Dr. Scott McGuffin  
Dr. Markian Pahuta**

**PGY-2**

**Dr. Andrew Bodrogi  
Dr. Paul Jamieson  
Dr. Bogdan Matache  
Dr. Kevin Rasuli  
Dr. Akshay Seth  
Dr. Andrew Stewart**

**PGY-4**

**Dr. Christopher Dowding  
Dr. Heathcliff D'Sa  
Dr. Adrian Huang  
Dr. Brian Le  
Dr. Andrew Tice  
Dr. Kristi Wood**

**PGY-1**

**Dr. Mahmoud Almasri  
Dr. Olivier Gauthier-Kwan  
Dr. Ivan Kamikovski  
Dr. Lisa Lovse  
Dr. Meaghan Marien  
Dr. Manisha Mistry**

**PGY-3**

**Dr. Mitchel Armstrong  
Dr. Aaron Frombach  
Dr. John Morellato  
Dr. Caleb Netting**

**FELLOWS**

**Dr. Marcel Abouassaly  
Dr. Abdulghader Alfasi  
Dr. Abdulhakeem Saeed B. Alqarni  
Dr. Khalid Alsheikh  
Dr. Helen Anwander  
Dr. Abdullah Arab  
Dr. William Desloges  
Dr. Christopher Kennedy  
Dr. Alexandre Pagé  
Dr. Sadegh Saberi  
Dr. Amardeep Singh  
Dr. Alexander Bent Tomic Loftkjaer**

**DIVISION OF ORTHOPAEDIC SURGERY**

**RESIDENCY TRAINING COMMITTEE**

**2014 – 2015**

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**Dr. Joel Werier**

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Dr. Wade Gofton  
Dr. Ken Kontio  
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**RESIDENT REPRESENTATIVES**

**Dr. Markian Pahuta  
Dr. John Morellato**

**DIRECTOR OF RESEARCH**

**Dr. Peter Lapner**

## **ACKNOWLEDGEMENTS**

**The Division of Orthopaedic Surgery greatly acknowledges the support of the  
H. K. Uthoff Research Day by the following companies:**

**Biomet Canada**

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## PROGRAM

- 0800 **Opening Remarks**  
Dr. Joel Werier, Director of the Orthopaedic Surgery Residency Training Program,  
University of Ottawa
- 0805 **Welcome/Introduction of Dr. Ginger E. Holt**  
Dr. Joel Werier, Division of Orthopaedic Surgery, University of Ottawa
- 0810 **Sarcomas and Incomplete Excisions - Why Can't We Get it Right?**  
Dr. Ginger E. Holt, Visiting Professor
- 0830 **Discussion**

## SESSION I

**MODERATOR: Dr. Geoffrey Dervin**

- 0840 1 **Metal Ion Levels Are Not a Useful Test for Failed Metal-on-Metal Hip Implants: A Systematic Review and Meta-Analysis**  
Dr. Markian Pahuta, PGY-5
- 0848 **Discussion**
- 0852 2. **Stability of a Novel Intramedullary Nail for the Treatment of Diaphyseal Femoral Fractures in the Developing World**  
Dr. Andrew Tice, PGY-4
- 0900 **Discussion**
- 0904 3. **Immunophenotypic Analysis of Peripheral Blood Lymphocytes in Patients with Hip Implant-Related Metal Hypersensitivity**  
Dr. Isabelle Catelas, Associate Professor and Canada Research Chair, Department of Mechanical Engineering, Department of Surgery, Department of Biochemistry, Microbiology and Immunology
- 0912 **Discussion**
- 0916 4. **A Pilot Randomized Controlled Trial of Iodine-Impregnated Plastic Adhesive Drape Usage in Spine Surgery and the Effect on Wound Bacterial Load**  
Dr. Brian Le, PGY-4
- 0924 **Discussion**
- 0928 5. **Comparing Factors Contributing to Cost-Overruns in Total Hip Arthroplasty**  
Dr. Adrian Huang, PGY-4
- 0936 **Discussion**
- Refreshment Break and Exhibits, Royal Room**

## SESSION II

**MODERATOR: Dr. Wade Gofton**

- 1030 6. Where are we going with bone-targeted agents in patients with bone metastases?  
Dr. Mark Clemons, Division of Medical Oncology, The Ottawa Hospital Cancer Centre
- 1038 Discussion
- 1042 7. Fixation of Anteromedial Coronoid Facet Fractures: Locking vs Non-locking vs Screw Constructs  
Dr. John Morellato, PGY-3
- 1050 Discussion
- 1054 8. Anatomical Analysis of the Syndesmosis using Novel Stress Computed Tomography in a Cadaveric Model  
Dr. John Morellato, PGY-3
- 1102 Discussion
- 1106 9. The Effect of Varying Tension of a Suture Button Construct in Fixation of the Tibiofibular Syndesmosis Evaluation Using Stress Computed Tomography  
Dr. John Morellato, PGY-3
- 1114 Discussion
- 1118 10. Surgical Dislocation of the Hip for Treatment of Prearthritic Hip Disease  
Dr. Amardeep Singh, Clinical Fellow
- 1126 Discussion
- 1130 11. Rates of Fat Embolism Syndrome Post Intramedullary Nailing of Lower Extremity Fractures at The Ottawa Hospital  
Dr. Mitchel Armstrong, PGY-3
- 1138 Discussion
- 1142 12. T1 $\rho$  Mapping in Hip Cartilage: a Comparative Study in Hips with and without Cam Type Deformity  
Dr. Gerd Melkus, Department of Medical Imaging, The Ottawa Hospital, Department of Radiology, University of Ottawa
- 1150 Discussion
- 1154 13. Follow up T1 $\rho$  in Hips after Surgery for Femoral Acetabular Impingement  
Dr. Manisha Mistry, PGY-1
- 1202 Discussion
- 1206 14. Hip Joint Stresses in Individuals with an Asymptomatic Cam Deformity during Level-Walking  
K.C. Geoffrey Ng, Graduate Student, Department of Mechanical Engineering, University of Ottawa
- 1214 Discussion
- Lunch and Exhibits, Royal Room

### **SESSION III**

**MODERATOR: Dr. Paul Kim**

- 1330 **Pathophysiology of Fatty Infiltration of the Cuff**  
**Dr. Hans K. Uhthoff**
- 1340 **Discussion**
- 1344 **Teamwork and Team Players - Success and Failure**  
**Dr. Ginger E. Holt, Visiting Professor**
- 1404 **Discussion**
- 1414 **15. Is the Anterior Approach Associated with a Higher Risk of Femoral Component Migration a Correlation with Radiolucencies?**  
**Dr. Alexandre Pagé, Clinical Fellow**
- 1422 **Discussion**
- 1426 **16. Mid Term Evaluation of Oxford Unicompartmental Knee Arthroplasty in Patients with BMI of 40 or Greater**  
**Dr. Akshay Seth, PGY-2**
- 1434 **Discussion**
- 1438 **17. An Exploration of the Inter-Relationships between Low Back Pain, Inflammation and Obesity**  
**Dr. Abdulghader Alfasi, Clinical Fellow**
- 1446 **Discussion**
- Refreshment Break, Amphitheatre B**

## SESSION IV

**MODERATOR: Dr. Stephen Kingwell**

- 1515 18. Trochanteric Fixation Using a Third Generation Cable Device – Ottawa’s Experience  
Dr. Andrew Stewart, PGY-2
- 1523 Discussion
- 1527 19. The Use of 3D Navigation in Subaxial Cervical Spine Lateral Mass Screw Insertion  
Dr. Abdullah Arab, Clinical Fellow
- 1535 Discussion
- 1539 20. In Vitro Simulation of Modular Neck Fracture, Wear and Corrosion in Total Hip Replacements  
Fahad Aljenaie, Graduate Student, Department of Mechanical Engineering, University of Ottawa
- 1547 Discussion
- 1551 21. Muscle Activation Patterns during Inclined Gait: Comparison between Medial Pivot and Posterior  
Stabilized Knee Prostheses  
Cat S. Czynny, Graduate Student, Department of Mechanical Engineering, University of Ottawa
- 1559 Discussion
- 1603 Closing Remarks  
Dr. Peter Lapner, Director of Research, Division of Orthopaedic Surgery, University of Ottawa

## ABSTRACTS

### 1. METAL ION LEVELS ARE NOT A USEFUL TEST FOR FAILED METAL-ON-METAL HIP IMPLANTS: A SYSTEMATIC REVIEW AND META-ANALYSIS

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Markian A Pahuta<sup>†</sup>, Jose M Smolders<sup>§</sup>, Job L van Susante<sup>§</sup>,  
Jonathan Peck<sup>†</sup>, Paul R Kim<sup>†,‡</sup>, Paul E Beaulé<sup>†,‡</sup>

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<sup>†,‡</sup>The Ottawa Hospital, Ottawa, Ontario, Canada

<sup>§</sup>Department of Orthopaedics, Rijnstate Hospital, Arnhem, The Netherlands

#### **Introduction**

Alarm over the reported high failure rates for metal-on-metal (MoM) hip implants as well as their potential for locally aggressive Adverse Reactions to Metal Debris (ARMDs) has prompted government agencies, internationally, to recommend the monitoring of patients with MoM hip implants. Some have advised that a blood ion level  $>7 \mu\text{g/L}$  indicates potential for ARMDs. It is unclear how this cut-point was defined, and it has been questioned by some surgeons and organizations. We report a systematic review and meta-analysis of the screening and diagnostic value of metal ion testing for ARMDs.

#### **Methods**

We electronically searched MEDLINE and EMBASE to identify articles from which it was possible to reconstruct a 2 x 2 table for the use of blood ion measurements as a test for ARMDs in patients with MoM hip implants. We supplemented the electronic search by obtaining referenced articles and citing articles for each of the articles ultimately included in the meta-analysis through Scopus. Two readers (a fellowship-trained joint reconstruction surgeon and orthopaedic surgery resident) independently reviewed all articles and extracted data using explicit criteria. We computed a summary receiver operating curve using a Bayesian random-effects hierarchical model.

#### **Results**

Our literature search returned 575 unique articles; only 6 met inclusion criteria define *a priori*. Study-specific estimates of specificity and sensitivity formed a common, smooth, ROC curve; however, there appeared to be variability in the performance of specific cut-points across different studies. This suggested that the discriminative capacity of ion tests was homogeneous across studies but that there was substantial cut-point heterogeneity. Our best estimate of the “true” AUC for metal ion testing is 0.615, with a 95% credible interval of 0.475-0.747, thus we can state that the probability that metal ion testing is actually clinically useful with an AUC  $\geq 0.75$  is 2.3%.

#### **Conclusion**

Metal ion levels are not useful as a screening test for identifying high risk patients because ion testing will either lead to a large burden of false positive patients, or otherwise marginally modify the pre-test probability. With the availability of more accurate non-invasive tests, we also see no role for using blood ion levels to diagnose symptomatic patients. We recommend that blood ion measurements remain a research tool.

## **2. STABILITY OF A NOVEL INTRAMEDULLARY NAIL FOR THE TREATMENT OF DIAPHYSEAL FEMORAL FRACTURES IN THE DEVELOPING WORLD**

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A. Tice, S. Carsen, R. Feibel

Division of Orthopaedic Surgery, University of Ottawa

### **Background**

Low-and Middle-income countries (LMIC) are burdened with a disproportionate amount of orthopedic trauma. A non-profit organization has developed an intramedullary nail for treatment of diaphyseal femoral fractures using a distal press-fit design. It eliminates the need for distal screws, decreases operative time, and removes a technically demanding step. The primary purpose of this study was to examine the post-operative radiographs of diaphyseal femur fractures treated with this implant for stability, in the form of subsidence. Secondary goals were to assess variables associated with increased risk of instability.

### **Methods**

A retrospective analysis of a prospectively populated database was performed. Surgeons at multiple centres populate the database with patient demographics and radiographs. Inclusion criteria were a diaphyseal femur fracture treated with the implant and a full data set. Cases with inadequate radiographs were excluded. For the 129 cases, data was recorded and radiographic measurements made. The primary outcome was nail subsidence with multivariate analysis of fracture location, classification (Winquist and AO/OTA), retrograde vs. antegrade insertion, nail length and diameter, and number of locking screws. A secondary outcome measure was coronal plane alignment.

### **Results**

The population was 84 males and 45 females, with an average age of 32.4 years (range 7–86). Average follow-up was 34 weeks. AO/OTA classification (32-A=91, 32-B=28, 32-C=10) and Winquist classification (1=92, 2=20, 3=11, 4=6) were assigned. In all fractures, there was no statistically significant subsidence from post-op to follow-up radiographs ( $p=0.732$ ). There was no statistical difference with relation to fracture location, antegrade or retrograde implantation, nail length, diameter or Winquist fracture classification. AO/OTA fracture classification showed that 32-C type fractures showed a significantly increased risk of subsidence ( $p=0.037$ ). A sub-group analysis for coronal plane alignment showed no statistically significant difference.

### **Conclusion**

This new implant design shows no statistically significant subsidence or coronal plane mal-alignment from post-op to follow-up radiographs. However, care should be taken with complex diaphyseal fractures (AO/OTA 32-C), as they show a higher risk of instability. The distal press-fit design of this novel implant provides adequate stability and is a viable option for the treatment of diaphyseal femur fractures in LMIC.

### 3. IMMUNOPHENOTYPIC ANALYSIS OF PERIPHERAL BLOOD LYMPHOCYTES IN PATIENTS WITH HIP IMPLANT-RELATED METAL HYPERSENSITIVITY

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Isabelle Catelas<sup>1,2,3</sup>; Eric A. Lehoux<sup>1</sup>; Ian Hurda<sup>3</sup>; Stephen J. Baskey<sup>1</sup>; Paul E. Beaulé<sup>2</sup>

<sup>1</sup>Department of Mechanical Engineering, University of Ottawa

<sup>2</sup>Department of Surgery, University of Ottawa

<sup>3</sup>Department of Biochemistry, Microbiology and Immunology, University of Ottawa

<sup>4</sup>Department of Biology, University of Ottawa

#### **Background**

Metal hypersensitivity remains a major cause for concern. A better understanding of the underlying mechanisms is therefore critical, especially since it will ultimately facilitate the development of new diagnostic methods and treatments of these reactions. The objective of this study was to identify which lymphocyte subpopulations are over - or under - represented in peripheral blood of patients with a failed hip implant and a strong to predominant hypersensitivity reaction, compared to patients with a failed implant and no or a mild hypersensitivity reaction, and to healthy subjects with no implant (controls). This comparison will reveal potential differences in the systemic immune response that are expected to reflect local differences in the periprosthetic tissues.

#### **Methods**

Mononuclear cells were isolated from peripheral blood of: 8 patients with a failed metal-on-metal (MM) hip implant and a strong to predominant hypersensitivity reaction (time to failure:  $3.5 \pm 0.9$  years), 7 patients with a failed MM or metal-on-polyethylene (MPE) hip implant and no or a mild hypersensitivity reaction (time to failure of  $5.1 \pm 5.9$  years), and 27 healthy subjects with no implant (controls). Lymphocyte subpopulations were analyzed by flow cytometry after cell immunostaining with specific surface and intracellular cytokine markers.

#### **Results and Discussion**

Significant differences between the three groups were observed for T-helper (Th) and T-cytotoxic (Tc) cells, as well as for total type 1 T cells (T cells expressing IFN- $\gamma$ ), and specifically type 1 Th and Tc cells. Overall, results showed larger relative proportions of Th cells and smaller relative proportions of total type 1 T cells, and specifically type 1 Th and Tc cells in the group with a strong to predominant hypersensitivity reaction compared to the other two groups. This suggests a lower number of these cells circulating systemically in this group of patients, which could reflect a sequestration of these cells in periprosthetic tissues (i.e., local site of the reaction), consistent with a type-IV hypersensitivity reaction. Nevertheless, this needs to be confirmed with absolute cell counts.

#### **Conclusion**

Results suggest the association of a type 1 Th (Th1) response with metal-induced reactivity. The observed phenotypic differences in peripheral blood lymphocytes could potentially become diagnostic markers for the detection of this type of reaction. Nevertheless, group sizes should be increased to confirm phenotypic differences, and results should be correlated to histological analyses of periprosthetic tissues.

#### **4. A PILOT RANDOMIZED CONTROLLED TRIAL OF IODINE-IMPREGNATED PLASTIC ADHESIVE DRAPE USAGE IN SPINE SURGERY AND THE EFFECT ON WOUND BACTERIAL LOAD**

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V. Le<sup>1</sup>, D.M. Roffey<sup>1,2</sup>, S.P. Kingwell<sup>1</sup>, P. Phan<sup>1</sup>, P. Macpherson<sup>3</sup>, M. Desjardins<sup>4</sup>, E.K. Wai<sup>1</sup>

<sup>1</sup>Division of Orthopaedic Surgery, University of Ottawa

<sup>2</sup>Clinical Epidemiology Program, Ottawa Hospital Research Institute

<sup>3</sup>Division of Infectious Diseases, Department of Medicine

<sup>4</sup>Division of Microbiology, Department of Pathology and Laboratory Medicine

##### **Purpose**

There is a paucity of high-quality evidence supporting, or refuting, the routine use of plastic adhesive drapes (PAD) to prevent surgical site infection (SSI). Intuitively, there are no foreseeable risks with PAD usage, and several potential benefits. However, there is conflicting literature suggesting no advantages, or even potential harm. Through this double-blinded, randomized controlled trial, we wanted to investigate the effect of PADs on bacterial colony-forming-unit (CFU) counts during elective spinal surgery by employing a novel, cost-effective low-risk methodology to further understand the effects at a microbiological level. We also sought to calculate sample sizes for future studies based on these pilot data.

##### **Method**

Over three months, 15 electively admitted, blinded spinal surgical patients were randomly assigned to PAD (3M Ioban 2) versus no PAD usage. A blinded observer collected surface specimens using flocked swabs (Copan eSwab) on surgical wound edges immediately post-operation (POD-0) and during the routine post-operation day 3 (POD-3) dressing change via a standardized swabbing technique. Specimens were quantitatively analyzed for bacterial CFU counts by growth on both blood agar and chocolate blood agar solid media. Specimens were plated in triplicate at two serial dilutions and CFUs were manually counted. Median CFU/cm of wound swabbed and percentage positive cultures were calculated, and statistical significance was assessed with the Mann-Whitney U test and Fisher's Exact test, respectively.

##### **Results**

There were no significant differences between groups in baseline demographics and SSI risk factors. POD-0, blood agar, median CFU/cm: no PAD=0 (range 0-7.69) vs PAD=0.04 (range 0-4.18) ( $P>0.2$ ); percentage positive cultures: no PAD=42.9% vs. PAD=50% ( $P=1.00$ ). POD-0, chocolate blood agar, median CFU/cm: no PAD=0.06 (range 0-7.51) vs PAD=0.09 (range 0-4.8) ( $P>0.2$ ); percentage positive cultures: no PAD=57.1% vs. PAD=62.5% ( $P=1.00$ ). POD-3, blood agar, median CFU/cm: no PAD=0.08 (range 0-1.87) vs PAD=0.22 (range 0-4.53) ( $P>0.2$ ); percentage positive cultures: no PAD=57.1% vs. PAD=50% ( $P=1.00$ ). POD-3, chocolate blood agar, median CFU/cm: no PAD=0.04 (range 0-2.22) vs PAD=0.04 (range 0-4.56) ( $P>0.2$ ); percentage positive cultures: no PAD=71.4% vs. PAD=75% ( $P=1.00$ ).

##### **Conclusion**

Our study demonstrated similar bacterial contamination whether a PAD was used or not. With the numbers available, we did not detect a significant difference between the two groups. Sample size calculations

## **5. COMPARING FACTORS CONTRIBUTING TO COST-OVERRUNS IN TOTAL HIP ARTHROPLASTY**

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Adrian L. Huang, Paul E. Beaulé

Division of Orthopaedic Surgery, University of Ottawa

### **Introduction**

Increasing unsustainable funding practices in Canada's single payer health system has led to various reforms throughout the nation in an effort to minimize cost while maintaining patient safety. Both total hip and total knee arthroplasty are included in health funding reforms and participate as quality based procedures. In this model, hospitals receive funding based on several factors, most importantly the Resource Intensity Weights (RIW), a multiplier given to each case depending on several patient and hospital related factors. As this funding comes into universal practice, the challenge remains to fall within funding limits for these procedures.

### **Purpose**

The purpose of this study was to identify and analyze the total costs of inpatient primary total knee and total hip arthroplasty cases comprising the cases in the 95<sup>th</sup> percentile or higher for cost. The goal was to identify key areas of reform to that may contribute to cost-minimization and allow hospitals to fall within newly allocated funding limits.

### **Methodology**

Detailed inpatient primary total hip and total knee arthroplasty case costs were collected from our institutional database. These had been recorded as per the Ontario Case Costing Initiative (OCCI) guidelines. The costs were compiled and divided into two groups, those beyond and those below the 95<sup>th</sup> percentile for total cost. These cases were analyzed and compared both internally and externally to provincial standards for cost based on the quality based procedure methodology and funding.

### **Results**

The preliminary cost analysis indicates that for total hip arthroplasty, the 95<sup>th</sup> percentile outlier cost was \$15,565, while average cost for non-outlier cases (<95<sup>th</sup> percentile) was \$9997. This represents a cost-minimization of approximately 36%. Similarly for total knee arthroplasty, the preliminary results for the 95<sup>th</sup> percentile outlier cost was \$13,440, while the average cost for non-outlier cases was \$9470. This accounts for an approximately 30% cost-minimization. Major contributors to cost included operating room costs, implant costs, nursing and floor costs, and inpatient physiotherapy costs.

### **Conclusion**

Fixed costs such as operating room and implant expenses are set by hospital contract. The minimization of costs based on patient stay such as floor costs and medication and food expenses must be optimized in order to fall within the funding limits of the quality-based procedures.

## **6. WHERE ARE WE GOING WITH BONE-TARGETED AGENTS IN PATIENTS WITH BONE METASTASES?**

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Mark Clemons

Division of Medical Oncology, The Ottawa Hospital Cancer Centre

Despite advances in cancer treatment, bone remains the most common site of metastasis for patients with the most common solid tumours. It is estimated that the prevalence of patients with bone metastases in Canada is around 100,000. Bone metastases are incurable and associated with significant morbidity such as fractures, pain, and reduced quality of life. Bone destruction occurs from disruption of the normal balance between bone resorption (by osteoclasts) and formation (by osteoblasts), resulting in net bone breakdown. Increased understanding of the pathogenesis of bone disease has resulted in the development of a number of bone-targeted agents (BTAs), the most widely used clinically being inhibitors of osteoclastogenesis and osteoclast activation (i.e. bisphosphonates, or denosumab).

When assessing the effects of BTAs on bone, clinical trials measure the frequency and timing of skeletal related events (SREs). Patients who experience SREs (a composite of: requirement for radiotherapy or surgery to bone, pathological fractures, spinal cord compression or hypercalcaemia) are at higher risk of further SREs, worsening of survival, and decreased quality of life. The clinical management of SREs are also associated with significant costs to the patient and the health care system. Thus, avoidance of SREs is an important clinical management goal for both patients and physicians. Studies in bone metastatic breast, prostate and lung cancer patients show that when BTAs are used in conjunction with endocrine or chemotherapy, they significantly reduce the incidence and delay the onset of SREs and are therefore widely prescribed for patients with bone metastases.

Patients with bone metastases are presently treated with BTAs every 3-4 weeks from the time of diagnosis of bone metastases for the remainder of their life. Historically, this dosing frequency was adopted for convenience rather than efficacy and safety purposes, as it allowed clinicians to deliver BTAs at the same time they were receiving chemotherapy (i.e. every 3 weeks) or oral therapies like tamoxifen (i.e. every 4 weeks). However, this rationale ignores the pharmacokinetics of BTAs which have a half-life in bone of many years. In this presentation I will talk about the current use of BTAs and some of the limitations of current practice.

## 7. FIXATION OF ANTEROMEDIAL CORONOID FACET FRACTURES: LOCKING VS NON-LOCKING VS SCREW CONSTRUCTS

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J Morellato<sup>1</sup>, H Louati<sup>1</sup>, W Desloges<sup>2</sup>, S Papp<sup>1</sup>, J Pollock<sup>1</sup>

<sup>1</sup>Division of Orthopaedic Surgery, University of Ottawa

<sup>2</sup>Division of Orthopaedic Surgery, Hull Hospital

### **Background/Purpose**

Fractures of the anteromedial facet (AO/OTA 21-B1.1, O'Driscoll Type 2, subtype 3) are associated with varus posteromedial rotational instability of the ulnohumeral joint and are associated with early post-traumatic arthritis. The method of fixation for these fractures has not been studied. The purpose of this study was to examine the stability of plate (locking and non-locking) vs screw constructs in the fixation of anteromedial coronoid facet fractures in a sawbone model.

### **Methods**

An anteromedial coronoid facet fracture (AO/OTA 21-B1.1) was simulated in twenty four synthetic ulna bones. They were then assigned into 3 fracture fixation groups: non-locking plate fixation, locking plate fixation, and dual cortical screw fixation. Six specimens were allocated to each of the plate fixation groups. A total of 12 specimens were allocated to the screw-only fixation group; 6 to be tested in compression and 6 to be tested in tension. Duplicate models were required in the screw-only fixation group as early failures were observed during the pilot testing.

An AO 2.0 mm screw and plate system was used for the plate fixation groups and 2.0 mm cortical screws were used for the screw-only group. Following fixation, each construct was potted in bismuth alloy and secured to a servohydraulic load frame. Each construct was first cycled in tension and then in compression at 0.5Hz. For both cycling modalities, an incremental loading pattern was used starting at 40 N and increased by 20 N every 200 cycles up to 200N. Fracture fragment displacement under cyclic loading was recorded with an optical tracking system. Following cyclic loading each construct was loaded to failure at 10mm/min. Failure was defined as fracture of the fragment or a displacement >2 mm.

### **Results**

*Tension cycling*—All constructs in the plated groups (locking and non-locking constructs) survived the cyclic tension loading protocol (to 200N) with maximum fragment displacement of 12.60um (SD 13.83um) and 14.50um (SD 9.48um) respectively. There was no statistical difference between the plated constructs at any load level. No screw-only fixed construct survived the tension protocol with mean force at failure 110N (range 60-180N).

*Compression Testing* - All constructs in the plated groups (locking and non-locking constructs) survived the cyclic compression loading protocol (to 200N), while 5 of the 6screw-only fixation constructs survived. Fracture fragment displacement was significantly greater in the screw-only repair group across all loading levels when compared to the plated constructs. There was no statistically significant difference in fragment motion between the locking and non-locking groups.

The mean fracture fragment end displacement for the screw-only construct was 64.20 um (SD 78.80um) with the mean end displacement for locking and non-locking constructs being 9.60um (SD 4.72um) and 10.83um (SD 10.83um) respectively.

## 8. ANATOMICAL ANALYSIS OF THE SYNDESMOSIS USING NOVEL STRESS COMPUTED TOMOGRAPHY IN A CADAVERIC MODEL

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J Morellato, H Louati, A Bodrogi, A Stewart, S Papp, A Liew, W Gofton

Division of Orthopaedic Surgery, University of Ottawa

### **Background/Purpose (hypothesis)**

Previous techniques for obtaining information regarding the tibiofibular syndesmosis, injury to this joint, as well as reduction and fixation have relied on plain radiographs, static computed tomography (CT) scans, and radiostereometric analysis. We have developed a novel cadaveric loading model that distributes a sustained axial, torsional, or combined load across the syndesmosis thereby allowing detailed assessment of the stressed joint via CT.

### **Methods**

Six cadaveric lower limbs disarticulated at the knee were used. The limbs were placed in a modified external fixator jig that allows for the application of sustained torsional (5 newton meters, Nm), axial (500 newtons, N) and combined torsional/axial (5Nm/500N) loading. Baseline unloaded and loaded CT scans were obtained and compared to characterize the intact joint geometry.

Four measurements were taken from an axial slice 10 mm above the tibiotalar joint; these included a measure of medial/lateral translation (ML), a measure of anterior-posterior translation (AP), a ratio of anterior-posterior translation (d/e), and an angle created by a line parallel to the incisura and the axis of the fibula (angle 1). For AP and ML, a positive number indicates movement in the anterior and medial directions. For the d/e ratio, a negative value signifies the fibula was translated posteriorly. A positive value for angle 1 indicates external rotation. These measurements have all been previously described. A paired t-test was used to compare the baseline to loaded conditions for each parameter.

### **Results**

The mean difference between the baseline and stressed specimens for each loading scenario are shown in Table 1, with standard deviations in parentheses.

Table 1:

<b>Load</b>	<b>AP</b>	<b>ML</b>	<b>d/e</b>	<b>Angle 1</b>
<b>Axial</b>	-0.54 (1.46)	-0.24 (0.88)	<b>-0.30 (0.20) *</b>	0.03 (2.5)
<b>Torsion</b>	-0.86 (2.22)	-0.01 (0.62)	<b>-0.65 (0.45) *</b>	<b>3.52 (1.51) *</b>
<b>Combined</b>	-1.63(2.36)	-0.67 (1.22)	<b>-0.67 (0.41) *</b>	<b>3.89 (1.56) *</b>

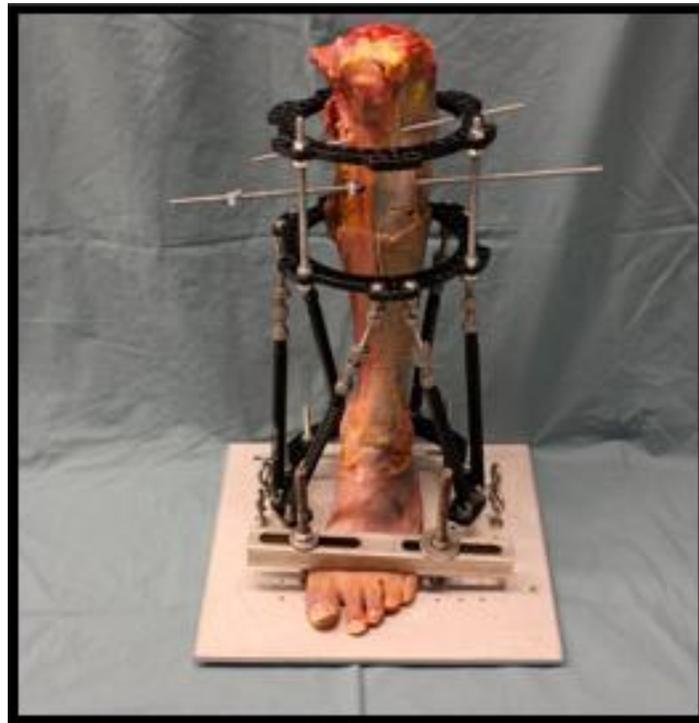
\*Significant difference from baseline p<0.05

This data shows that when stressed, the fibula translates posteriorly and externally rotates which is in keeping with our current understanding.

Loading in torsion has the largest contribution to movement of the fibula in a stressed syndesmosis, however, axial loading does have an additive effect in the combined loading scenario.

## Conclusion

We have developed a novel sustained loading model that allows for characterization of the tibiofibular syndesmosis joint geometry using CT. The model was used to examine the effects of axial, torsion and combined loads on an intact joint. This model has further application in assessing reduction/malreduction and examining different fixation constructs under various loading conditions.



**Figure 1.** Custom External fixator jig with mounted cadaveric specimen in an unloaded condition

## **9. THE EFFECT OF VARYING TENSION OF A SUTURE BUTTON CONSTRUCT IN FIXATION OF THE TIBIOFIBULAR SYNDESMOSIS – EVALUATION USING STRESS COMPUTED TOMOGRAPHY**

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### **Background/Purpose**

Traditional screw fixation of the syndesmosis can be prone to malreduction. Suture button fixation however, has recently shown potential in securing the fibula back into the incisura even with intentional malreduction. Yet, if there is sufficient motion to aid reduction, the question arises of whether or not this construct is stable enough to maintain reduction under loaded conditions. To date, there have been no studies assessing the optimal biomechanical tension of these constructs. The purpose of this study was to assess optimal tensioning of suture button fixation and its ability to maintain reduction under loaded conditions using a novel stress CT model.

### **Methods**

Eight cadaveric lower limbs disarticulated at the knee were used. The limbs were placed in a modified external fixator jig that allows for the application of sustained torsional (5 newton meters, Nm), axial (500 newtons, N) and combined torsional/axial (5Nm/500N) loads. Baseline unloaded and loaded CT scans were obtained. Bone tunnels were pre-drilled to pass the suture button devices prior to sectioning of the syndesmosis, ensuring no malreduction prior to drilling. The Syndesmosis and the deltoid ligament complex were then sectioned. The limbs were then randomized to receive a suture button construct tightened at 4kg force (loose) or 8 kg (standard tightness).

Four measurements were taken from axial slices 10 mm above the tibiotalar joint: a measure of medial/lateral translation (ML), a measure of anterior-posterior translation (AP), a ratio of anterior-posterior translation (d/e), and an angle created by a line parallel to the incisura and the axis of the fibula (angle). These measurements have all been previously described. Each measurement was taken at baseline and compared with the 3 loading scenarios. A repeated measures ANOVA with a Bonferroni correction for multiple comparisons was used to test for significance.

### **Results**

The mean difference between the baseline repaired and stressed repaired specimens is shown in figure 1a. Significant posterior translation was seen in the 4 kg group with axial loading when measurement AP was compared. Additionally, ratio d/e showed significant posterior translation in both the 4kg and 8kg groups under torsion and combined loads. There was significant external rotation of the fibula under axial load in the 4kg group when compared with baseline scans. Additionally, when compared with the 8kg group, the 4kg group showed significantly more external rotation under the same torsional load (12.03 vs 8.63 degrees). Both groups showed a trend of increasing external rotation especially under torsional loading.

### **Conclusion**

Stress CT demonstrated notable motion with a suture button fixation construct, especially under torsional loads. Care should be taken to ensure that this construct is properly tensioned and loads should be minimized until healing has occurred.

## 10. SURGICAL DISLOCATION OF THE HIP FOR THE TREATMENT OF PREARTHROTIC HIP DISEASE

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### **Purpose**

The purpose of this study was to report the clinical results and complications of surgical dislocation of the hip in the treatment of pre-arthritis hip disease from a single center.

### **Methods**

Data was prospectively collected on 82 patients (89 hips) who underwent a surgical dislocation of the hip between 2005 and 2010, by a single surgeon. Clinical outcome measures including the modified Harris Hip Score, the HOOS, the UCLA Activity Scale, and SF-12 were collected pre-operatively and yearly follow-up. Radiographic assessment involved a well-centered antero-posterior radiograph and specialized lateral view (Dunn View).

### **Results**

At a mean follow-up of 7.1 years (range 5 – 9.6) clinical function improved significantly. 6 patients were converted to total hip arthroplasty and 3 patients underwent an arthroscopy and an additional three patients had >1mm of joint space narrowing at latest followup giving us a 9-year cumulative Kaplan-Meier survivorship of 86.4% (CI, 79% to 94%). Thirty-four patients underwent internal fixation removal at a mean of 12.0 months (range 0.3-40.8 months).

### **Conclusion**

Although effective in the treatment of early hip disease, the surgical dislocation approach carries a high re-operation rate for removal of internal fixation, consequently less invasive approaches should be considered for less complex deformities.

## 11. RATES OF FAT EMBOLISM SYNDROME POST INTRAMEDULLARY NAILING OF LOWER EXTREMITY FRACTURES AT THE OTTAWA HOSPITAL

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### **Purpose**

Fat embolism Syndrome (FES) is a rare entity, usually occurring following trauma or orthopaedic surgery. Our study reviews the rate of FES occurring over a 10-year period at The Ottawa Hospital following intramedullary nail placement for lower extremity fractures. In addition, we analysed the CT thorax imaging appearance of the affected patients. We attempted to correlate CT imaging with the severity of the clinical picture in hopes of providing an imaging predictor of patient's requiring respiratory support in intensive care.

### **Methods**

This study is a retrospective analysis of 1208 patients who had undergone lower limb intra-medullary nailing for traumatic fractures over a ten- year period in two tertiary care centres. Post-operative respiratory distress, of significant severity to require a CT Thorax, occurred in thirty-seven patients. Thirteen patients met clinical and radiological criteria suspicious for FES (Mean age 38, 18-80yrs 13M, 0F). Four patients suffered a fulminant course requiring intensive care admission. Medical imaging was reviewed independently by two radiologists for features previously reported to occur in FES. Parameters thought to reflect disease severity, such as percentage of lung involvement and radiographic features of pulmonary hypertension were also acquired and correlated with the patient's disease onset and clinical course.

### **Results**

Of the 1208 patients undergoing lower extremity intramedullary nailing, 1.2% were felt to have fat embolism syndrome based upon both clinical and radiologic parameters. Eight patients had a non-fulminant course requiring supportive care with no intubation. Four patients required admission to the intensive care unit for ventilator support. There was one death in the fulminant group. Average number of fractures in the fulminant group was 3 (range 1-6) and 1.2 (range 1-2) in the non-fulminant group. The most commonly occurring imaging feature in FES is that of patchy or diffuse ground glass opacities. These were present in 10 of the patients. All 4 of the patients who required ventilator support demonstrated extensive ground glass opacities (>75% lung involvement) and increased calibre of the main pulmonary artery. Clinically, a time delay of >24hrs between fracture and intramedullary nail fixation increased the likelihood of a fulminant clinical course. The 9 patients who had a mild course and were managed on the ward, had a tendency for less lung involvement (6 patients <25%, 2 >75%). All but one of the non-fulminant cases had undergone intramedullary nail fixation in the first 24hrs.

### **Conclusion**

We found a 1.2% rate of FES following intramedullary nailing for lower extremity fractures. CT Thorax is a useful diagnostic tool to aid in the diagnosis of fat embolism syndrome. The most typical imaging appearance is that of ground glass opacities, either patchy or diffuse. The degree of lung involvement correlates with likelihood of a fulminant clinical course requiring intensive care support.

## 12. T1ρ MAPPING IN HIP CARTILAGE: A COMPARATIVE STUDY IN HIPS WITH AND WITHOUT CAM TYPE DEFORMITY

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### **Introduction**

Osteoarthritis (OA) of hip is a debilitating and painful condition. In the literature it is suggested that up to 80% of adult idiopathic hip OA cases are caused by femoroacetabular impingement (FAI)<sup>1,2</sup>. Standard clinical imaging techniques are unable to assess early osteoarthritis (OA) in hip cartilage, but it has been shown that quantitative T1ρ MRI has the potential to detect early biochemical cartilage degeneration in OA<sup>3</sup>. In this study we systematically investigated the analysis for T1rho images of hip cartilage in healthy subjects as well as asymptomatic and symptomatic subjects with cam deformities.

### **Methods**

In 57 hips (57 subjects) T1ρ imaging was performed on a 1.5 T MRI scanner. 40 hips were diagnosed with cam-type deformity, 17 showed no deformity and were included in the control group. 18 hips in the cam-type deformity group were symptomatic and scheduled for surgery, 22 hips were asymptomatic. The clinical score WOMAC was assessed in all subjects at time of MRI. T1ρ maps were calculated and analysed with custom written software implemented using MATLAB. The femoral and acetabular cartilage were analysed parallel to the acetabular plane as a whole and divided into 3 mm thick slices (total of 9 slices). In each slice the cartilage was analysed as a bilayer divided into 6 zones, each a 30° wide wedge in the sagittal plane. Further, the total 54 regions (9 slices x 6 zones) were combined to six regions of interest (ROIs), following a described hip cartilage T1rho pattern in healthy subjects<sup>4</sup>. The anterior zones 1-3 were combined to the anterosuperior quadrant and the posterior zones 4-6 to the posterosuperior quadrant. The lateral slices 1-3 were combined to the lateral third, slices 4-6 to the intermediate third and slices 7-9 to the medial third.

### **Results**

The previously described pattern<sup>4</sup> of lower T1ρ values in the anterosuperior region was found in control hips but not in hips with a cam-type deformity. Comparing hips with a cam-type deformity and control hips, significantly prolonged T1ρ values were found in the entire hip cartilage with cam-type deformity, based on significantly prolonged T1ρ values in the lateral third of the anterosuperior quadrant as well as in the medial third in both, the anterosuperior and posterosuperior quadrants. No significant difference was found between symptomatic and asymptomatic hips with a cam-type deformity. A significant correlation between T1ρ values in the entire hip cartilage and WOMAC subscore pain in symptomatic hips was found. Regarding the ROI, a significant correlation was found in the lateral third of the anterosuperior quadrant with the total WOMAC score as well as the subscores pain and stiffness and in the medial third of the posterosuperior quadrant with the total WOMAC score and the subscorepain.

## **Discussion**

In hips with cam-type deformity, a significant T1 $\rho$  prolongation indicating loss of proteoglycan (PG) was found in the lateral third of the anterosuperior quadrant. This is where the cam-type impingement occurs and early cartilage damage is expected. Additionally, a significant T1 $\rho$  prolongation was found in the medial third in both the anterosuperior and posterosuperior quadrant. This indicates the degeneration of the cartilage occurs also without a direct contact to the deformity. The fact that no significant difference was found between symptomatic and asymptomatic hips with cam-type deformity indicates that the cartilage damage occurs in all hips with cam-type deformity. A correlation between T1 $\rho$  prolongation, indicating early cartilage damage, and the pain level was shown. This correlation was strongest in the lateral third of the anterosuperior quadrant, the region of direct impact of the deformity.

## **Conclusion**

Quantitative T1 $\rho$  imaging has the potential to detect cartilage PG loss in patients with cam-type FAI deformities, correlates with clinical scores and the results indicate T1 $\rho$  imaging may be used as a diagnostic marker in hips with cam-type deformity. We propose to divide the hip cartilage into the six described ROIs for T1 $\rho$  analysis.

## **References**

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### 13. FOLLOW UP T1rho IN HIPS AFTER SURGERY FOR FEMORAL ACETABULAR IMPINGEMENT

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#### **Introduction**

Femoral acetabular impingement (FAI), a common structural hip deformity, is a major cause of early osteoarthritis, in young adults. Symptomatic patients found to have FAI deformities can undergo hip-preserving surgery to remove and repair offending deformities. Recent emergence of T1rho MRI mapping has been shown to be a reliable imaging technique to assess the proteoglycan content of cartilaginous tissues, inferring degree of osteoarthritic progression in joints.

#### **Methods**

This study analyzes spatial MRI T1rho levels in hip joint cartilage pre and post surgery for FAI. Pre-operative and 2-year postoperative T1rho MRIs were performed on 24 patients who underwent hip-preserving surgery for FAI at a single centre by a single surgeon. All hips had cam-type FAI deformity, with or without pincer-type lesions. The acetabulum was spatially divided, with levels of T1rho in cartilage quantified as a whole and in each spatial segment.

#### **Results**

No significant difference was found between pre and post-op T1rho levels. Significant correlation was found between pre-op alpha angle at 1:30 and difference between pre-op and post-op total cartilage T1rho content (R: -0.653; P:0.038). This correlation is reflected solely in the posteriosuperior quadrant of the hip (R: -0.695; p: 0.038), but not the anterosuperior quadrant (p>0.05). Preop T1rho levels were found to significantly correlated with the difference between pre-op and post-op T1rho in entire hip cartilage (R: 0.731; p:0.016). This correlation was reflected both in the anterosuperior quadrant (R: 0.867; p:0.002), and in the posteriosuperior quadrant (R:0.702; p:0.035). Additionally, significant correlation was found between improvement of WOMAC pain score over time, and difference of T1rho values over time in the most lateral 3mm slice of the anterosuperior quadrant (R: 0.81; p:0.045).

#### **Conclusion**

These data reflect that hip-preserving surgical intervention can lead to a regression of osteoarthritic changes in patients with FAI. These changes are both location-specific and correlated with degree of preoperative deformity.

## 14. HIP JOINT STRESSES IN INDIVIDUALS WITH AN ASYMPTOMATIC CAM DEFORMITY DURING LEVEL-WALKING

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### **Purpose**

It is still unclear why certain individuals with a cam deformity go on to develop symptomatic femoroacetabular impingement (FAI) and degenerative changes, while others will remain asymptomatic for most of their adult life. The purpose was to compare hip joint stresses in individuals with an asymptomatic cam deformity to the symptomatic and control populations.

### **Methods**

Nine male participants ( $n = 9$ ; age =  $32 \pm 6$  years, BMI =  $25 \pm 4$  kg/m<sup>2</sup>): 3 symptomatic (cam deformity with symptoms), 3 asymptomatic (cam deformity without symptoms), and 3 control participants (no deformity or symptoms) were recruited. Pelvic CT and MRI data were acquired from each participant, to reconstruct 3D hip joint models, and level-walking trials were captured at the Human Movement Biomechanics Laboratory. Inverse kinematics, kinetics, and static optimization were performed using a musculoskeletal modelling program, where resultant hip contact forces were determined and applied onto the 3D models. Finite element simulations determined peak maximum-shear stresses magnitudes and spatial distributions on each participant's acetabular cartilage.

### **Results**

The symptomatic participants also showed decreased femoral neck-shaft angles, an anatomical characteristic significantly associated with FAI symptoms. The symptomatic group showed elevated stresses at the antero-lateral cartilage ( $6.1 \pm 1.6$  MPa), while the control group experienced much lower stresses along the supero-lateral acetabulum ( $2.7 \pm 0.9$  MPa). The asymptomatic group resembled the symptomatic group, but demonstrated lower peak stresses ( $3.8 \pm 1.0$  MPa).

### **Conclusion**

A cam deformity does provide the complete picture in regards to the likelihood for symptoms. The differences between the symptomatic and asymptomatic groups further supports that a decreased femoral neck-shaft angle may be an indicator of those at-risk of developing early symptoms. The symptomatic group's elevated stresses could be attributed to pre-existing labral-chondral damage, leading to incongruent articulations and poor contact mechanics. This could be due to neuromuscular adaptation mechanism to avoid pain by altering directions of the force vectors. The coxavara structure plays a major role in seating the cam deformity further into the acetabulum, which can further explain differences in clinical signs among the FAI population and the lack of early symptoms reported by asymptomatic individuals.

## 15. IS THE ANTERIOR APPROACH ASSOCIATED WITH A HIGHER RISK OF FEMORAL COMPONENT MIGRATION A CORRELATION WITH RADIOLUCENCIES?

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### Introduction

It has been suggested that the less invasive surgical approaches for THR such as the anterior approach (AA) may be associated with a greater risk of femoral component migration. A literature review did not reveal a study comparing the AA and the PA. The purpose of the study was to compare migration patterns of a cementless femoral stem implanted through the direct anterior approach versus the posterior approach (PA). We then looked at radiolucencies and tried to correlate if it could predict component migration.

### Patients & Methods

Eighty-four patients (AA: 40, PA: 42) matched for age (AA: 67.8yrs  $\pm$  9.8, PA: 66.9yrs  $\pm$  10.4), gender (AA: 21F, PA: 27F), and BMI (AA: 29.4kg/m<sup>2</sup>  $\pm$  5.8, PA: 28.4kg/m<sup>2</sup>  $\pm$  6.0) were retrospectively analyzed for femoral component migration using Ein-Bild-Roentgen-Analyse Femoral component analysis (EBRA-FCA) after undergoing THR for degenerative arthritis with a tapered cementless stem. All patients had a minimum of 4 consecutive radiographs. Subsequently, we reviewed the last follow up xray of each patient to analyze for radiolucencies. Using the Gruen zone, we plotted the size of each radiolucencies for each zones. Using the White and all criteria of significant radiolucencies (3 or more zone with greater than 1.5mm radiolucencies).

### Results

At a mean follow-up of 29.5mos ( $\pm$ 15.7), the overall mean femoral component migration was not significantly different between AA (-1.22 $\pm$ 2.7mm) and PA (-0.87 $\pm$ 0.98mm), p=0.45 with a mean migration rate of -0.36 $\pm$ 1.0mm/yr and 0.76 $\pm$ 1.0mm/yr, respectively. Eight AA and 4 PA had an overall migration >2.0mm.

Follow-up (mths)	AA		PA		p value	Difference (95% confidence interval)
	Number of Hips	Subsidence (mm) $\pm$ sd	Number of hips	Subsidence (mm) $\pm$ sd		
0-24	19	-0.15 $\pm$ 1.57	32	-0.98 $\pm$ 0.85	0.044	0.83 (0.89 to 1.56)
24-48	15	-1.63 $\pm$ 1.47	6	-0.13 $\pm$ 1.36	0.049	1.50 (0.84 to 2.09)
48-72	6	-3.57 $\pm$ 5.40	4	-1.18 $\pm$ 1.14	0.33	2.39 (1.62 to 6.91)
Over 72	0	N/A	0	N/A	N/A	N/A

### Mean migration over time according to approach

WOMAC total scores improved for both groups with no significant difference: AA. pre 49.1 $\pm$ 18.4 to 82.0 $\pm$ 22.7 versus 40.7 $\pm$ 16.5 pre to 83.0 $\pm$ 16.2 for PA.

Three AA patients (Infection, aseptic cup loosening, unexplained Pain) and four PA (acetabular loosening, dislocation, failure of polyethylene liner and infection) underwent revision THR none for femoral loosening.

There was no correlation between Posterior AP and Lateral Radiolucencies and subsidence. There was a low negative correlation between Anterior AP/Lat Radiolucencies and subsidence and no correlation between any Post/Ant Radiolucencies versus functional outcomes. 1 patient in the Anterior approach had significant radiolucencies (3 measurements in 3 different zones over 1.5mm (1)) and no Posterior approach had significant lucencies. No correlation could be identified between significant radiolucencies and migration pattern.

### **Significance**

The overall mean femoral component migration was under the 1.5mm threshold in both groups and not significantly different between groups. Both groups had components which had migrated greater than 2mm overall none of which have required revision. The anterior approach does not increase the risk of femoral component migration. Looking at radiolucencies, as a correlation to migration pattern, does not seem to predict the migration pattern using RSA technology. This outcome reinforces that the anterior approach is a safe approach for total hip arthroplasty. The approach to the femur, although more technically challenging, does not create any significant increase in implant migration or radiolucencies at a mean follow up of 29.5 months.

## 16. MID TERM EVALUATION OF OXFORD UNICOMPARTMENTAL KNEE ARTHROPLASTY IN PATIENTS WITH BMI OF 40 OR GREATER

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### **Introduction**

The role of unicompartmental knee arthroplasty (UKA) for medial compartment osteoarthritis of the knee in patients with a high BMI continues to be controversial. An increasing body of literature outlines the results of UKA in obese patients but there has been little published on patients with class III obesity. In this prospectively followed database review, we present the survivorship of Oxford UKA in patients with BMI  $\geq$  40.

### **Methods**

Our prospectively monitored database was mined to capture consecutive patients with a BMI  $\geq$  40 who were treated with Oxford mobile bearing UKAs since February 2001. Each patient was reviewed for failure (defined as revision to a total knee arthroplasty for any reason) and clinical outcome as determined by the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) and the Knee Injury and Osteoarthritis Outcome Score (KOOS). Univariate statistics were used to evaluate the roles of weight, gender and age as predictors of UKA revision.

### **Results**

The review identified 124 UKAs in 101 patients (66 females and 35 males). Mean age was 57.6 years (range 42-75, SD 6.6), median BMI was 42 (range 40-65), and mean follow up was 5.7 years (range 0.9-12.6, SD 2.9). There were 13 failures (10.5%), 12 of which were in females. The mean time to revision was 3.44 years (range 1.25-7.6) and Kaplan-Meier survivorship analysis revealed survival rates of 99.2%, 95.6%, 87.9% and 83.6% at one, two, five and ten years, respectively. Female gender was a significant predictor of failure with an odds ratio of 7.6. Causes for revision included six for arthritis progression (three lateral compartment, three patellofemoral compartment), three for unexplained knee pain and four with tibial component subsidence (two with associated bearing dislocation). The cohort had significant improvement on all WOMAC ( $p < 0.001$ ) and KOOS ( $p = 0.032$  or less) subscores. Patients with failed UKAs had significantly worse pain (WOMAC  $p = 0.013$ , KOOS  $p = 0.006$ ), stiffness (WOMAC  $p = 0.04$ ) and function in sport/recreation (KOOS  $p < 0.001$ ) than non-revised patients. Their ADL functional outcomes were worse but did not reach statistical significance.

### **Discussion**

This study includes the largest non-designer cohort of patients with a BMI  $\geq$  40 having undergone an Oxford UKA in the literature. UKA survivorship in this cohort is similar to the previously published survival rates for patients with BMI  $\geq$  30. Patients who underwent a revision had significantly worse pain, stiffness and sport/recreation function than non-revised patients. Female gender was a significant predictor of failure and was an unexpected finding. Further research is needed to evaluate how the Oxford UKA survivorship in these patients compares to that of non-obese patients and those with class I/II obesity. Female patients with BMI  $>$  40 should be cautioned about an increased revision risk with this procedure.

## 17. AN EXPLORATION OF THE INTER-RELATIONSHIPS BETWEEN LOW BACK PAIN, INFLAMMATION AND OBESITY

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### **Introduction**

Low back pain (LBP) is a common musculoskeletal disorder. Numerous potential sources of LBP have been identified, but the etiology remains equivocal. Many studies have showed a relationship between obesity and LBP due to a combination of mechanical, structural, metabolic, and behavioral factors. Recently however, associations between obesity and inflammation, inflammation and pain signaling, and LBP and inflammation have also been postulated.

### **Methods**

In this retrospective chart study, we collected data on n=62 consecutive, non-surgical, chronic LBP patients who presented for a consultation appointment with a spine surgeon at The Ottawa Hospital. Patients completed baseline pain and function questionnaires (i.e. 0-10 pain scores, Oswestry Disability Index, EuroQol-5D) and provided demographic details (e.g. height, weight, working status, and exercise levels). At this same consultation visit, blood work was collected, inclusive of the following inflammatory and diabetic markers: white blood cell (WBC), erythrocyte sedimentation rate (ESR), C-reactive protein (CRP) and hemoglobin A1c (HbA1C).

### **Results**

In regards to ESR, 47.5% of patients had values (average:  $15.7 \pm 9.7$  mm/hr) that were above normative values (6.0 mm/hr). Similarly, 47.1% of patients reported HbA1C values (average:  $7.3 \pm 2.1\%$ ) above normative values (6.0%). Patients with high WBC, ESR, CRP or HbA1C values were more likely to be female, in their mid-50's, a non-smoker, have a BMI around  $26 \text{ kg/m}^2$  and clearly indicate predominant back pain (range: 7.5 – 8.7 out of 10) versus left or right leg pain (range: 2.8 – 5.9 out of 10).

### **Conclusion**

Almost 50% of non-surgical, chronic LBP patients presented with a significant inflammatory or pre-diabetic status. Further larger studies need to be conducted to investigate the impact of systemic inflammation and/or poorly controlled blood glucose levels as contributors to LBP. Exploring the impact of exercise and its mediating effects in these patients may also be warranted.

## 18. TROCHANTERIC FIXATION USING A THIRD GENERATION CABLE DEVICE – OTTAWA'S EXPERIENCE

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### **Background**

Trochanteric non-union/insufficiency fracture is a common Arthroplasty complication, resulting from transtrochanteric approaches to the hip, periprosthetic hip fractures and more recently, osteolysis related bone resorption. With the growing hip arthroplasty population, the incidence of trochanteric fracture is expected to be an ongoing problem. Cable-plate devices combining circlage cable with trochanteric plates were introduced over 40 years ago to provide a rigid construct that would oppose the massive forces transmitted through the greater trochanter and provide a stable environment for healing.

Third generation cable-plate devices were recently introduced with advancements in biomechanical design. Despite a paucity of evidence for their use, they have been the primary implant for trochanteric fixation at our institute. Only one clinical trial has thus far been performed assessing their use, which revealed a reoperation rate of 4.3% and a union rate of 95.7%.

The **objective** of this study is to investigate the rates of reoperation and trochanteric non-union after using the Accord cable-plate system at The Ottawa hospital in the past 6 years.

### **Methods**

We retrospectively reviewed 52 consecutive applications of the Accord Cable-Plate system for greater trochanteric fixation from Feb 2008 to Mar 2014 with the following indications: periprosthetic fracture (n=26), complex primary arthroplasty (n=8), complex revision arthroplasty (n=18). Radiographic analysis of bony apposition and union was performed as previously described by Hamadouche et al. Primary outcomes included rates of reoperation and radiographic union. There were 32 patients with over 6 months of follow up (death n=9, unable to return for radiographs n=7, unable to contact n=4). Exclusion criteria for reoperation rate included loss of contact before 6 months (n=4). Exclusion criteria for union rate included less than 6 months of radiographic follow-up 9 (n=20).

### **Results**

Reoperations in which the Accord system was removed was performed for 15 patients (31.3%) at a mean of 8.1 months (range 0.5-39.0 months) post insertion. Indication for implant removal included: lateral hip pain (5/15), infection (5/15), periprosthetic fracture (1/15), trochanter fragment escape (1/15), and removal of hardware during revision for other reasons (3/15). Radiographic assessment at minimum 6 months showed bony union in 19/32 and fibrous union in 3/32 applications of the cable-plate system.

### **Conclusions**

Despite similar indications for Accord cable-plate implant use, we observed significantly higher reoperation rates (31.3%) and lower trochanteric union rates (68.8%) than previously described in the literature.

## 19. THE USE OF 3D NAVIGATION IN SUBAXIAL CERVICAL SPINE LATERAL MASS SCREW INSERTION

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### **Background**

Stabilization of the c-spine is typically achieved by lateral mass screws (LMS). The use of 3D navigation in identifying the ideal trajectory for the LMS has not been fully investigated. Insertion of LMS using the 3D navigation may or may not reduce the intraoperative or postoperative complications. The purpose of this study to show if there is any difference observed in terms of complications whether using the 3D navigation system or using the freehand technique

### **Methods**

A prospective study was performed for a total of 40 patients. Twenty patients had their LMS inserted using the 3D navigation system, while the other twenty had their LMS inserted by using the traditional technique. Ethics approval was obtained for this study. Adults who required subaxial LMS insertion were included. Demographic data were compared between the two groups. Intraoperative events (spinal cord injury, vertebral artery injury, root injury etc ) were captured and all patients had postoperative CT scan for assessment of screws positions, lateral mass fractures, rod breakage and screws loosening. Means and SD were calculated. Events proportions were calculated and outcomes were compared between the two groups using Z test. All statistical tests were calculated at alpha level of 5%.

### **Results**

A total of 285 LMS were inserted in 40 patients. The mean age for the 3D navigation group was 62.4 (CI 5.6) while for the other group was 64.6 (CI3.7). No statistical difference between the two groups in regard to their demographic data. Screws malposition was statistically different between the two groups p 0.01 . There was no statistical differences in regard to vertebral artery injury, spinal cord injury, nerve root injury or hospital stay. Intraoperative lateral mass fractures were also higher in the standard group.

### **Conclusion**

The use of 3D navigation in LMS insertion will decrease the rate of screw malposition (facet, foramen transversarium) as compared to the traditional technique. This may reduce the surgical complications and improve the patients' outcome.

## 20. IN VITRO SIMULATION OF MODULAR NECK FRACTURE, WEAR AND CORROSION IN TOTAL HIP REPLACEMENTS

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### **Background**

The various sizes and geometries of femoral necks available for modular hip implants allow the surgeon to optimize a patient's range of motion and leg length. However, some *in vivo* modular neck retrievals have shown signs of early fatigue and advanced wear-corrosion at the neck-stem interface. The purpose of this study was to reproduce *in vivo* fatigue fracture, wear and corrosion at the neck-stem interface in an *in vitro* setting to better predict failure mechanisms and implant limitations. The effects of neck material (Ti6Al4V and CoCrMo) and implant assembly technique (hand-assembly and impact-assembly) on fatigue life and corrosion resistance were investigated.

### **Methods**

All implants were obtained from MicroPort Orthopedics Inc. Ti6Al4V stems and CoCrMo heads were used in all constructs. Both fatigue and corrosion tests were performed under cyclic loading at a frequency of 10Hz with 12/12 hour load/rest cycles. The neck-stem interface was immersed in phosphate buffered saline at 80 °C in order to accelerate corrosion, the fatigue tests were conducted under a maximum compression load of 7.0 kN for 1.3 million cycles, while the corrosion tests were conducted under a maximum compression load of 2.3 kN for 5.0 million.

### **Results**

In fatigue testing, all hand-assembled Ti6Al4V necks failed within 1.3 million cycles. None of the impact-assembled Ti6Al4V and CoCrMo necks (hand- and impact-assembled) showed signs of failure. The corrosion tests revealed signs of moderate wear-corrosion on both Ti6Al4V and CoCrMo necks. Moreover, some of the fatigue tests produced higher levels of corrosion than those seen in corrosion testing. The Ti6Al4V stems showed higher levels of corrosion when tested with CoCrMo necks compared to those tested with the Ti6Al4V necks.

### **Conclusion**

The use of CoCrMo necks and impact assembly technique may substantially increase implant fatigue life. The presence of wear-corrosion in fatigue tests suggests that increased mechanical load may be the major factor in accelerating simulated implant surface damage and inducing higher wear-corrosion in the *in vitro* setting.

## 21. MUSCLE ACTIVATION PATTERNS DURING INCLINED GAIT: COMPARISON BETWEEN MEDIAL PIVOT AND POSTERIOR STABILIZED KNEE PROSTHESES

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### **Purpose**

In severe osteoarthritis, total knee arthroplasty (TKA) improves function and decreases pain. Post-TKA however, discrepancies remain in biomechanics comparing with healthy controls [1]. Increased quadriceps activity and hamstrings co-activation can potentially cause increased wear at the knee [1]. While prosthetic design may affect biomechanics [1], there is little research into the effects of implant design on muscles. This study aimed to investigate differences in resulting muscle activity between medial pivot (MP) and posterior stabilized (PS) prostheses during incline gait.

### **Methods**

Subjects having undergone unilateral TKA with a MP (N=13; age=61.9±6.4 years, BMI=29.8±4.5 kg/m<sup>2</sup>, post-op=11±3 months) or PS (N=6; age=68.3±3.6 years; BMI=29.8±4.5 kg/m<sup>2</sup>; post-op=9±2 months) implant were recruited. Motion data and vertical ground reaction forces were collected during gait on a 4m ramp inclined at 12.5%. EMG data were collected the operated and non-operated side muscles: vastus lateralis (VL), vastus medialis (VM), rectus femoris (RF), biceps femoris (BF), and semimembranosus (SM). Custom-made software normalized EMG signals by their maximum voluntary isometric contractions (MVIC) and calculated integrated EMG (iEMG) and antagonist co-activation indices (CI). Unpaired t-tests ( $\alpha=0.05$ ) were conducted to compare MP and PS groups.

### **Results**

The PS group demonstrated significantly higher levels of muscle activity in the operated RF muscles, compared to MP group, during ascent and descent (Ascent: PS=116 $\hat{A}$ ±10V/V, MP=72 $\hat{A}$ ±7V/V,  $p=0.034$ ; Descent: PS=145 $\hat{A}$ ±20V/V, MP=82 $\hat{A}$ ±10V/V,  $p=0.02$ ). As well, the PS group experienced significantly higher activation of the non-operated RF muscle during descent (152 $\hat{A}$ ±18V/V, MP=77 $\hat{A}$ ±9V/V,  $p=0.043$ ) and the VL activation for both ascent (PS=256 $\hat{A}$ ±23V/V, MP=156 $\hat{A}$ ±11V/V,  $p=0.004$ ) and descent (PS=173 $\hat{A}$ ±23 $\hat{A}$ ±V/V, MP=125 $\hat{A}$ ±13V/V,  $p=0.039$ ). The PS group also demonstrated higher antagonist CI in the operated side (PS=0.88 $\hat{A}$ ±0.11V/V, MP=0.75 $\hat{A}$ ±0.16V/V,  $p=0.075$ ).

### **Conclusions**

The MP group demonstrated lower quadriceps activity than the PS group. The MP group also showed lower co-activation in the non-operated limb. Higher VL, as in the PS group, has been seen previously [2]. The higher co-activation found in the PS group may be linked to risks of contra-lateral OA post-TKA [2]. Lower muscle activity in the VL and RF indicate higher quadriceps efficiency in the MP group. Further research examining the influence of prosthetic design on muscles and biomechanics is required.

## **References**

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