

**Canadian Orthopaedic Association (COA) and Canadian  
Orthopaedic Research Society (CORS) Annual Meeting  
Abstract Supplement**

**June 15 - 18, 2017**

**Westin Hotel and Shaw Convention Centre  
Ottawa, Ontario, Canada**

**COA President: Dr. Peter B. MacDonald, Winnipeg, Manitoba, Canada**

For inquiries please contact the COA office at: [meetings@canorth.org](mailto:meetings@canorth.org)

**Total abstracts: 131**

## COA Hand and Wrist / Upper Extremity

### 1. DYNAMIC CT SCAN OF THE NORMAL SCAPHOLUNATE JOINT IN A CLENCHED FIST AND RADIAL AND ULNAR DEVIATION

**Presenter: Paul Kelly, NL**

J. Hopkins, NL, A. Furey, NL, D. Squire, NL

The purpose of this study was to evaluate the motions of the scapholunate joint in normal wrists in a clenched fist and through radial and ulnar deviation using dynamic CT imaging.

Fifteen participants under 40 years of age consented to have their wrist scanned. Eight participants were randomised to have the right wrist scanned, and seven for the left wrist. Volunteers were positioned at the back of the gantry and selected wrist was placed on the table, palmar side down. Participants began with the hand in a relaxed fist position and then proceeded to clench the hand in a full fist and relax. Once relaxed again, the wrist was then maximally ulnar deviated and then maximally radially deviated. Dynamic CT imaging was captured throughout the range of motion.

The movement in the healthy scapholunate joint through a clenched fist and radial and ulnar deviation is minimal. The averages were 1.19mm, 1.01mm and 0.95mm, representing the middle, dorsal and volar measurements respectively.

This novel dynamic CT scan of the wrist is a user friendly way of measuring of the scapholunate distance, which is minimal in the normal wrist under 40 years of age.

### 2. THE DAILY MOTION OF ANATOMIC AND REVERSE TOTAL SHOULDER ARTHROPLASTY RECONSTRUCTED SHOULDERS

**Presenter: G.Daniel G. Langohr, ON**

J. Haverstock, ON, J. Johnson, ON, G. Athwal, ON

The daily *in vivo* motion of total shoulder arthroplasty (TSA) and reverse total shoulder arthroplasty (RTSA) reconstructed shoulders is largely unknown. A clearer understanding of the cumulative daily motion of each type of reconstruction would be helpful in the design and testing of shoulder prostheses, yielding insight into how many cycles of motion represents one year of clinical use. The purpose of this study was to measure and compare the cumulative daily shoulder motion of patients with TSA vs. RTSA.

Twenty-one patients who had undergone TSA (75±6yrs) and 17 patients who had undergone RTSA (72±11 yrs) wore a custom instrumented garment capable of measuring global shoulder motion during the waking hours of one day. The garment incorporated three sensors; one located on the torso and one on each humerus, each using a tri-axial accelerometer, gyroscope, and compass to measure its orientation in space. The 3D orientation of each humeral sensor was transformed with respect to the torso to allow for the calculation of humeral elevation and plane of elevation angles. Joint angles for each subject were then discretised by identifying the peaks and valleys of humeral elevation and motion was then determined. The motions of TSA and RTSA reconstructed shoulders were then compared.

Both the TSA and RTSA shoulders had similar frequency of motion; on average, the TSA shoulders had 1453±742 motions/hour, and the RTSA shoulders had 1496±696 motions/hour (Figure 1, p=0.86). When motion was discretised based on range of elevation angle, for elevation angles less than 60° the RTSA shoulders exhibited 7±6% more motion than the TSA shoulders (Figure 1, p=0.8). For elevation angles between 60° and 120°, TSA shoulders exhibited 18±12% more motion than RTSA shoulders (Figure 1, p=0.87).

The daily motion of both TSA and RTSA reconstructed shoulders was not significantly different (1453±742 and 1496±696 motions/hour respectively). Overall, discrete motions above 120 degrees of elevation account for less than about 3% of total motion. Novel insight into the daily motion of TSA and RTSA shoulders is presented, which may assist in the design and testing of shoulder arthroplasty prostheses.

### **3. CHARACTERISATION OF THE WALCH B3 GLENOID IN PRIMARY OSTEOARTHRITIS**

**Presenter: Kevin Chan, NY**

N. Knowles, ON, G. Walch, France, J. Chaoui, France, L. Ferreira, ON, G. Athwal, ON

The Walch B3 glenoid has been described as a progression of the B2 biconcave deformity. It is characterised by a neoglenoid region that involves 100% of the glenoid surface, resulting in medialisation, retroversion and posterior humeral head subluxation. The purpose of this 3D imaging study was to describe the morphologic characteristics of B3 glenoids.

Fifty-two patients (mean age of  $72 \pm 8$  years, 22 male, 30 female) with a B3 erosion pattern underwent 3D analysis of CT scan data using a validated software system. 3D glenoid version, inclination, and medialisation were determined. Posterior subluxation of the humeral head was assessed both according to the scapular plane and the glenoid plane. Additionally, the measured glenoid morphologic variables were compared between males and females, and between younger and older patients.

The average 3D glenoid version for the entire B3 cohort was  $24^\circ \pm 7^\circ$ , inclination was  $8^\circ \pm 6^\circ$  superior, and medialisation was  $14\text{mm} \pm 4\text{mm}$ . The mean posterior humeral head subluxation was  $80\% \pm 8\%$  according to the scapular plane and  $54\% \pm 6\%$  according to the glenoid plane. There were no statistical differences in the glenoid characteristics between males and females. Similarly, there were no differences in the glenoid variables between younger patients ( $\leq 65$  years old) and older patients. A significant correlation was identified between glenoid version and degree of humeral head subluxation according to the scapula plane, with every  $1^\circ$  increase in retroversion translating into 1% increase in posterior humeral head subluxation ( $p < 0.001$ ). In contrast, according to the glenoid plane, the humeral head remained concentric to the erosion.

The B3 glenoid is an acquired uni-concave arthritic deformity associated with retroversion and posterior humeral head subluxation. As glenoid retroversion increases in a B3 pattern, the degree of posterior humeral head subluxation significantly increases as referenced to the scapular plane. According to the glenoid plane, however, the humeral head appears concentric to the erosion. This appearance of "concentricity" is acquired secondary to the erosion pattern creating a uni-concave glenoid face. As such, surgeons must be aware that the visualised "concentricity" is a product of the posterior humeral head subluxation and the resultant B3 erosion pattern.

### **4. DEVELOPMENT OF A HAPTIC GLENOID REAMING SIMULATOR FOR SHOULDER ARTHROPLASTY**

**Presenter: Jonathan R. Kusins, ON**

J. Strelzow, Scotland, M. Lebel, ON, L. Ferreira, ON

Glenoid reaming is a technically challenging surgical step required during total shoulder arthroplasty. Surgical simulation training is a viable option for developing complex procedural skills, while minimising patient risk. Glenoid reaming generates tactile vibration feedback that expert surgeons use proficiently. This haptic vibration feedback could be implemented in surgical simulation to enhance the realism of the virtual training environment. This study focused on 1) quantification of glenoid reaming vibrations, and 2) development of a novel haptic glenoid reaming simulator to improve surgical skills during total shoulder arthroplasties.

An experiment quantified vibrations specific to tissues (cartilage/subchondral/cancellous) encountered during glenoid reaming. An accelerometer was mounted to a reamer shaft and a standard concentric reaming technique was performed on five porcine specimens by a fellowship-trained shoulder surgeon. The root-mean-square acceleration (g-rms) and a 1/3 octave analysis (range 20-250 Hz) were calculated for each tissue layer. A custom haptic glenoid reaming simulator was fabricated, employing a vibration transducer, a load cell, a 3D printed glenoid (from clinical CT), and a functional surgical reamer fitted with a non-wearing tip. System calibration was performed by matching peak-to-peak (pk-pk) vibration amplitudes generated by the simulator to the experimentally recorded benchmark. The root-mean-square acceleration for both experimental and simulated

waveforms was also calculated for validation. Custom software simulated tissue transitions by calculating reamed depth based on the magnitude and timing of the user's applied force, calibrated from the experimental data.

Cartilage reaming produced the lowest vibrations ( $0.18 \pm 0.04$  g-rms) compared to subchondral ( $0.32 \pm 0.05$  g-rms) and cancellous bone ( $0.37 \pm 0.06$  g-rms). The 1/3 octave analysis did not discover any distinctive peaks within any frequency bands. System calibration resulted in a perfect match of 3.51 g pk-pk compared to the experimental benchmark. The total energy transmitted to the user during simulation was 0.36 g-rms compared to 0.30 g-rms experimentally.

Our system replicated the vibrational profile recorded during cadaveric reaming, confirming its ability to simulate realistic haptic feedback. Cartilage produced the lowest dynamic effects for total energy compared to subchondral and cancellous bone. The lack of a distinct tissue-specific frequency peak may suggest that surgeons rely on vibrations in the time domain (total energy, pk-pk amplitude, etc.) rather than a specific frequency. The tactile transducer to transmit vibration profiles provided a realistic simulation, and the system's ability to quantify simulated reaming depth provides performance feedback to the user. These results will facilitate development of a realistic shoulder arthroplasty simulator, which may improve skills acquisition and provide quantifiable competency-based assessments.

## **5. BIOMECHANICAL EVALUATION OF THE SCAPHOLUNATE LIGAMENT AND SECONDARY STABILISERS ON SCAPHOID AND LUNATE KINEMATICS**

**Presenter: Clare Padmore, ON**

H. Stoesser, ON, G.D.G.Langohr, ON, N. Suh, ON, J. Johnson, ON, G. King, ON

The scapholunate ligament (SLL) is a commonly injured intercarpal ligament, and is considered the primary stabiliser of the SL joint, but a complex configuration of secondary stabilisers including the scaphotrapezium-trapezoid ligament (STTL) and radioscaphocapitate ligament (RSCL) may also contribute to SL kinematics. The anatomy of the SLL and other wrist ligaments have been established, yet the functional role of each ligament in controlling carpal motion remains unclear. This *in vitro* study quantified scaphoid and lunate kinematics during wrist flexion-extension following sequential sectioning of the SLL and secondary stabilisers.

Cadaveric upper limb specimens ( $n=8$ ,  $74 \pm 11$  yrs) were amputated mid-humerus. To quantify carpal motion, optical trackers were attached to the scaphoid and lunate under fluoroscopic control, as well as the third metacarpal and radius. The wrist flexors/extensor tendons were exposed and sutured at their musculotendinous junction. Specimens were mounted on a wrist motion simulator in neutral rotation with the elbow at  $90^\circ$  flexion. Muscle tone loads were produced using servomotors connected via cables to each muscle group. Five cyclic motion trials of wrist flexion-extension were performed at 5mm/sec for each stage (S1: intact wrist, S2: dorsal SLL cut, S3: complete SLL cut, S4: SLL & STTL cut, S5: SLL, STTL, & RSCL cut). Data was analysed from  $\pm 45^\circ$  wrist flexion-extension, reported in  $5^\circ$  increments.

In flexion, there was a significant increase in scaphoid flexion ( $p=0.01$ ) and lunate extension ( $p=0.01$ ) following ligament sectioning. Each consecutive sectioning stage significantly increased scaphoid flexion compared to the intact wrist (S2  $1.5 \pm 1.5^\circ$ ,  $p=0.02$ ; S3  $4.4 \pm 3.3^\circ$ ,  $p=0.007$ ; S4  $4.5 \pm 3.8^\circ$ ,  $p=0.01$ ; S5  $4.6 \pm 3.7^\circ$ ,  $p=0.01$ ). There were significant increases in lunate extension for S3-S5 when compared to the intact wrist (S3  $3.5 \pm 3.6^\circ$ ,  $p=0.03$ ; S4  $3.9 \pm 3.8^\circ$ ,  $p=0.03$ ; S5  $4.8 \pm 4.6^\circ$ ;  $p=0.02$ ). In extension, there were no significant changes in scaphoid motion ( $p=0.7$ ) but there was a significant increase in lunate extension after ligament sectioning ( $p=0.03$ ). S4 and S5 caused a significant increase in lunate extension when compared to the intact wrist (S4  $3.5 \pm 4.1^\circ$ ,  $p=0.05$ ; S5  $4.3 \pm 4.2^\circ$ ,  $p=0.02$ ).

SLL sectioning caused significant changes in scaphoid and lunate kinematics, while subsequent STTL and RSCL sectioning induced small but significant changes. Following sectioning of the SLL, STTL and RSCL the scaphoid flexed more during wrist flexion and the lunate extended more throughout wrist flexion and extension. While the magnitude of these changes were relatively small compared to the changes observed in patients with SLL injuries, this suggests that other ligaments may be disrupted or become gradually attenuated over time

clinically. A better understanding of the functional role of the primary and secondary ligamentous structures at the SL joint may assist in the development of more effective treatment strategies following SLL injury.

## **6. THE EFFECT OF ASSOCIATED FRACTURES/DISLOCATIONS ON OUTCOMES OF UNRECONSTRUCTABLE RADIAL HEAD FRACTURES MANAGED WITH RADIAL HEAD ARTHROPLASTY: A COHORT COMPARISON**

**Presenter: Jason A. Strelzow, Scotland**

G. Athwal, ON, J. MacDermid, ON, R. Grewal, ON, K. Faber, ON, D. Drosdowech, ON, G. King, ON

Displaced radial head fractures are common injuries with controversy regarding the most appropriate treatment algorithm. Complexity of the injury is a potential contributor to variability in outcomes in unreconstructable fractures.

This study compared physical impairments and patient reported outcomes of patients with simple as compared to complex injuries treated with a radial head arthroplasty. Patients with isolated elbow trauma and no prior injury to the elbow were prospectively enrolled following radial head arthroplasty for an unreconstructable fracture. Injury patterns were subgrouped as simple or complex (associated fractures and/or dislocation).

Patients (n= 148) were subgrouped into 67 simple and 81 associated fracture/dislocation injury patterns. At a minimum one-year follow-up (mean 1.7 years) outcome scores, PREE (p=0.8) and QuickDASH (p=0.34), and ROM and strength values were similar (all p values >0.05). Patients evaluated out to a mean of seven years (range, 5-15 years) demonstrated no effect of injury pattern on clinical outcomes at any time point (p>0.05). Continued statistical improvements in PREE (p=0.8) and QuickDASH (p=0.34), and ROM and strength values were similar (all p values >0.05). Patients evaluated out to a mean of seven years (range, 5-15 years) demonstrated no effect of injury pattern on clinical outcomes at any time point (p>0.05). Continued statistical improvements in PREE (p<0.05), supination ROM (p=0.003), and flexion ROM (p<0.05) at medium-term compared to earlier follow-up was observed. Eight patients required secondary surgery, two in the simple injury group and six complex injury patients (p=0.09). Overall, patient satisfaction was 8.7±2.3 out of ten for simple and 8.9±2.1 for complex injuries (p=0.66).

Concomitant elbow injuries do not affect the longer term outcomes of patients with unreconstructable radial head fractures requiring radial head arthroplasty. Patient outcomes continued to improve beyond two years of follow-up.

## **7. BICEPS TENODESIS VERSUS TENOTOMY IN TREATMENT OF LESIONS OF LONG HEAD OF BICEPS BRACHII IN PATIENTS UNDERGOING ARTHROSCOPIC SHOULDER SURGERY**

**Presenter: Jeff Leiter, MB**

P. MacDonald, MB, S. McRae, MB, G. Stranges, MB, J. Old, MB, J. Dubberley, MB, R. Mascarenhas, TX, M. Nassar, MB, P. Lapner, ON

To compare patient-reported and objective results between biceps tenotomy and tenodesis in patients with lesions of the long head of biceps tendon (LHBT).

The study is a prospective, randomised, controlled trial targeting patients +18 years undergoing arthroscopic shoulder surgery to manage a lesion of the LHBT (+/- rotator cuff repair). Patients were excluded if they had previous surgery on their affected shoulder or any other significant medical co-morbidity that could alter the effectiveness of the surgical intervention. Patients were allocated intraoperatively to undergo tenodesis or tenotomy via computer randomisation once a LHBT lesion was confirmed. The primary outcome measure was the American Shoulder and Elbow Society standardised assessment of shoulder function (ASES). Secondary outcomes included: Western Ontario Rotator Cuff Index (WORC), surgery time, patient reported pain and cramping, presence of a cosmetic deformity, elbow flexion and supination strength, and power. Study time points were pre, and three, six, 12, and 24 months post-operative. Magnetic resonance imaging (MRI) was conducted at 12-months post-operative.

Fifty-six participants were randomly assigned to each group, and collection of data to 24-months post-operative is ongoing until 2017). There were no differences in ASES score at pre or post-surgery time points ( $p=0.74$ ). At 12 months, mean ASES score for the tenodesis group was 79.6 (SD 20.3) compared to 77.9 (20.2) for the tenotomy group. Similarly, no differences were found in WORC, surgery time, pain or cramping. One strength difference was identified at only the six month time point, when the ratio of affected versus unaffected elbow flexion strength was greater in the tenodesis group (0.9 (SD 0.2)) compared to the tenotomy group (0.8 (SD 0.3) ( $p=0.04$ ). No other strength differences between groups were found for elbow flexion or supination strength, or power. Relative risk of cosmetic deformity reported by patients in the tenotomy group relative to the tenodesis group was 1.36 at 12 months post-surgery which is not significant ( $p=0.41$ ). MRI findings were available on 40 patients at the 12 month post-operative time point. Of 23 in the tenodesis group, one was not intact and retracted 18 cm and two were partially torn. Of the 17 in the tenotomy group, none appeared retracted. Arthroscopic treatment of lesions of LHBT, whether tenodesis or tenotomy, was shown to have favourable results. Elbow flexion strength favoured tenodesis at six months, but otherwise there were no significant differences between groups. As data continues to be gathered to 24 months, longer-term benefits and drawbacks of each procedure may become evident.

## **8. ARTHROSCOPIC DEBRIDEMENT FOR PRIMARY ELBOW OSTEOARTHRITIS WITH AND WITHOUT CAPSULECTOMY: A COMPARATIVE COHORT STUDY**

**Presenter: Ahaoiza Diana Isa, ON**

G. King, ON, G. Athwal, ON, K. Faber, ON

Arthroscopic elbow debridement for primary osteoarthritis may be conducted with or without an anterior joint capsulectomy. Although it is believed that a capsulectomy may be associated with better restoration of motion, it may also be associated with a higher risk of iatrogenic neurovascular injury. The purpose of this comparative cohort study was to compare early complications and range of motion between patients with and without anterior capsulectomy.

One hundred and ten patients with primary osteoarthritis of the elbow who underwent an arthroscopic debridement for stiffness, impingement pain and/or locking were reviewed. Patients were required to have a minimum of three months post-operative follow-up to be included in the study. Fifty-one patients had a concomitant capsulectomy and 59 did not.

There were no significant differences between the groups in age, gender, dominant extremity, occupation classification, worker's compensation status, presence of ulnar nerve symptoms, history of previous surgery, and duration of symptoms ( $p>0.05$ ). There was significantly greater stiffness in the group who had a concomitant anterior capsulectomy ( $36^\circ - 123^\circ$ ) vs. those who did not ( $28^\circ - 127^\circ$ ) ( $p<0.001$ ). A greater improvement in ROM occurred in patients who had a concomitant capsulectomy ( $19^\circ - 130^\circ$ ) compared to patients without ( $21^\circ - 132^\circ$ ) ( $p<0.003$ ) however, there were no significant differences in final range of motion between groups ( $p=0.582$  for extension and  $p=0.777$  for flexion). There were two patients in each group with complications during the study period requiring re-operation. There was no statistically significant difference in the incidence of minor complications between the groups, 22% and 14% for those with and without a capsulectomy respectively ( $p=0.268$ )

The incidence of early complications was low at this tertiary referral centre with no significant difference between groups. Elbow arthroscopy and debridement for primary elbow osteoarthritis yields satisfactory motion at short-term follow-up with or without a concomitant capsulectomy.

## **9. ISOLATED CAPITATE FRACTURES: CASE REPORT AND SYSTEMATIC LITERATURE REVIEW**

**Presenter: Mina Aziz, MB**

J. Leiter, MB, J. Guiffre, MB

Isolated capitate fractures have traditionally been thought to be rare injuries. However, due to the increasing use of advanced imaging modalities such as MRI and CT, the medical community is starting to recognize the true incidence of this injury. This project seeks to highlight the unique features of this injury by presenting the case of a 27-year-old male with an isolated capitate fracture and the results of a systematic literature review. We hypothesize that missed capitate fractures result in increased risk of developing a non-union as well as avascular necrosis (AVN).

A literature review was conducted in the following databases; Ovid Medline, Ovid EMBASE, Web of Science and SCOPUS. Exclusion criteria were age less than 18 at time of injury, the presence of concomitant carpal bone fractures and non-English language articles. The data from the selected articles was extracted and their references were cross checked against our articles. Statistical analysis was conducted including relative risk as well as the Fisher exact-test.

Twenty-three original articles meet our inclusion criteria, with a total of 29 individual cases (including our case). These articles consisted predominantly of case reports and case series. There were five females and 24 male patients with a mean age of 26 (range 18-42). Only eight cases representing 28% of fractures were recognized on initial presentation. Eleven fractures resulted in a non-union with a relative risk of two (P 0.39). There were four cases of confirmed AVN and two more cases were suspected to have AVN with a relative risk 2.35 (P 0.62).

There was a delay in the diagnosis of isolated capitate fractures in 72% of the cases. While our results did not confirm our hypothesis, we hope that increased awareness of this injury pattern will improve our understanding of the natural history of this injury and help guide future treatment plans.

### **2016 J.A. Nutter Award Winner**

#### **Characterization of Posterior Glenoid Bone Loss in Posterior Shoulder Instability**

**Presenter: Jason J. Shin, University of Saskatchewan**

A.B. Yanke, R.M. US, Frank, N.N. Verma, US, B.J. Cole, US, A.A. Romeo, US, M.T. Provencher, US

Although glenoid bone loss has been well characterized in the setting of anterior shoulder instability, little has been written in the literature in the setting of posterior instability. The purpose of this study was to characterize the morphology and location of posterior glenoid bone loss in patients with posterior instability utilizing computed tomography (CT).

Clinical data was selected for patients with posterior shoulder instability that had undergone posterior stabilization (open or arthroscopic) or posterior osseous augmentation (distal tibia or iliac crest). The axial cuts were segmented and reformatted in three-dimensions for glenoid analysis using Osirix software. From this three-dimensional model, the following was calculated: percent bone loss (Nobuhara), total arc of the defect (degrees), glenoid version, and a clock-face description (start point, stop point, and average of direction-all normalized to right shoulder). Pearson correlation coefficients were performed using significance of  $p < 0.05$ .

Forty-nine shoulders from 49 patients were reviewed. Twenty patients (average age 26.5 years; 95% males) had evidence of posterior glenoid bone loss and were included for evaluation. Defects on average involved 13.7±8.6% of the glenoid (range, 2-35%). The average start time (assuming all right shoulders) on the clock face was 10 o'clock ± 40 minutes and stopped at 6:25 ± 35 minutes. The average direction of the defect pointed towards 8:14 ± 23 minutes. The percent bone loss correlated with the total arc of the defect (Pearson: 0.93,  $p < 0.05$ ,  $R^2: 0.86$ ). The direction of bone loss moved more postero-superiorly, as the defect became larger (Pearson: 0.63,  $P < 0.05$ ,  $R^2: 0.40$ ).

Posterior bone loss associated with posterior glenohumeral instability is typically directed posteriorly at 8:14 on the clock. As defect gets bigger, this direction moves more posterosuperiorly. This information will help guide clinicians in understanding the typical location of posterior bone loss aiding in diagnosis, cadaveric models and treatment.

## COA Paediatrics

### **10. NON-TRAUMATIC PAEDIATRIC ORTHOPAEDIC REFERRALS IN MANITOBA. (A RETROSPECTIVE REVIEW OF 680 CONSECUTIVE CONSULTATIONS, THEIR APPROPRIATENESS, AND IMPLICATIONS FOR FUTURE CANADIAN GUIDELINES)**

**Presenter: G.Brian Black, MB**

M. Raghavan, MB, A. Sprange, MB

Musculoskeletal problems account for 20-30% of paediatric medical problems. Forty to 65% of referrals to Paediatric Orthopaedic Surgeons (POS) involve common conditions that could be diagnosed and managed by primary health care providers. The American Academy of Paediatrics Surgical Advisory Panel (AAPSAP) published guidelines for making referrals to paediatric specialists. There are no equivalent guidelines in Canada and there are no published studies regarding referral patterns to POS's in Canada. We wanted to quantify the frequency and trends of unnecessary referrals made to the Section of Paediatric Orthopaedic Surgery (SPOS) at the Children's Hospital of Winnipeg.

A retrospective chart review evaluated non-trauma referrals (n=680) to the SPOS. The AAPSAP referral guidelines were used to determine the appropriateness of the referrals. The X test was used to compare categorical variables. Statistical significance was set at  $P < 0.05$ .

We found that 499 (73.4%) of the referrals were unnecessary. The majority of referrals were from general practitioners (47.4%) and paediatricians (30%). Torsional variations (98.4), musculoskeletal pain/overuse injuries (94.3), angular variations (89.9) and idiopathic scoliosis (88.1) accounted for the conditions with the greatest rate of unnecessary referrals.

Not only is there a significant number of unnecessary non-trauma paediatric orthopaedic referrals to SPOS, but there appears to be a predictable pattern of unnecessary referrals. This emphasises the importance of developing and implementing a set of Canadian paediatric orthopaedic referral guidelines.

### **11. THE IMPACT OF A WEB-BASED CLINICAL PRACTICE PATHWAY FOR SUPRACONDYLAR FRACTURES ON RESOURCE UTILISATION**

**Presenter: Anshika Gangwar, ON**

J. Menna, ON, M. Camp, ON

In an effort to standardise management and reduce overtreatment of uncomplicated paediatric fractures, we developed evidence-based paediatric fracture pathways to assist primary-care physicians, emergency room physicians and orthopaedic surgeons in making decisions about appropriate and effective care for their patients. The first pathway published on our hospital website was for Type 1 supracondylar humerus fractures. The aim of this study was to determine the impact of this pathway on hospital and clinic resource utilisation.

A comparative retrospective review was performed at a tertiary-care paediatric hospital. Clinic data from two 11 week periods before and after implementation of the fracture pathways were compared: August 4 - October 17, 2014; and August 3 - October 16, 2015. For each study period, data collected included: total number of Type 1 supracondylar fractures in the study period, number of clinic visits per patient, number of radiology department visits from fracture clinic, number of x-rays ordered from fracture clinic, number of orthopaedic technologist visits, and the number of patients requiring operative orthopaedic intervention. Student t-tests were used to compare patient data before and after the implementation of the pathways.

The mean number of clinic visits per patient with a Type 1 supracondylar humerus fracture decreased from 2.3 in 2014 to 1.6 in 2015 ( $p=0.0001$ ). The mean number of radiology department visits ordered from fracture clinic per patient decreased from 2.2 in 2014 to 1.1 in 2015 ( $p=0.0001$ ). The mean number of x-rays ordered from fracture clinic per patient decreased from 5.3 in 2014 to three in 2015. The mean number of orthopaedic technologist visits decreased from 1.8 in 2014 to 1.2 in 2015 ( $p=0.002$ ). Physician adherence to the pathway was



only 52%. Reasons for physician non-adherence included lack of confidence in radiographic diagnosis (58%) and lack of knowledge of pathway existence (42%).

The implementation of a web-based fracture pathway for Type 1 supracondylar humerus fractures was associated with a decrease in resource utilisation at a tertiary-care paediatric hospital. Research in progress is determining reasons for non-adherence, methods to improve adherence to the pathway and whether the results are sustainable.

## **12. TODDLER'S FRACTURE OF THE TIBIA: AN UNNECESSARY FRACTURE CLINIC REFERRAL**

**Presenter: John Adamich, ON**

M. Camp, ON

There is increasing evidence that many uncomplicated paediatric fractures can be definitively managed by emergency room physicians or primary care physicians without orthopaedic surgeon follow-up (e.g. distal radius buckle fractures). This strategy leads to a reduction in radiation exposure and decreased costs to patient families and the healthcare system without impacting patient outcomes. The aim of this study was to determine whether patients who sustained a toddler's fracture of the tibia required orthopaedic surgeon follow-up.

A retrospective analysis of patients who presented to a tertiary-care paediatric hospital between January 2009 and December 2014 for management of a toddler's fracture of the tibia was performed. Inclusion criteria consisted of patients between the ages of zero and four who had a confirmed toddler's fracture on initial radiograph. Patients with perinatal injury, multiple fractures, non-accidental injury, underlying bone disease, fractures with shortening, fractures with >2mm displacement were excluded from the analysis.

One hundred and eighty-six patients (115 males, 72 females) with an average age of two (range 0.2-3.9) were included in the study. Patients were in the cast for an average of 25.9 ( $\pm 10.3$ ) days. Initial management typically occurred with above or below knee back slab splint (70.9%) followed by a definitive circumferential cast at the first follow-up visit (57.6%). No patient developed a non-union nor re-fractured. To date, no patient has returned to clinic or undergone surgery for concerns regarding leg length inequality or mal-alignment. The mean number of clinic visits including initial consultation in the emergency department was two ( $\pm 1$ ). The mean number of radiology department appointments was 2.76 ( $\pm 1.1$ ) where patients received a mean number of 5.86 ( $\pm 2.6$ ) radiographs. No differences in patient outcomes were associated with different immobilisation methods, however, circumferential casts required an additional visit to the orthopaedic technologist for application and removal of the casts.

Our series supports reduced clinical follow-up of patients with a toddler's fracture of the tibia. If the diagnosis can be made on the initial radiographs, emergency room physicians or primary care providers can definitively manage these patients with appropriate immobilisation that can be removed by the parents between three to four weeks after the injury. A fracture clinic follow-up is only necessary if the diagnosis cannot be made on the initial radiographs. Circumferential casts are unnecessary, necessitate an additional visit for cast removal and place the patient at risk for cast saw injuries.

## **13. DEVELOPMENT OF THE FIRST PROVINCE/STATE-WIDE HIP SURVEILLANCE PROGRAM FOR CHILDREN WITH CEREBRAL PALSY IN NORTH AMERICA: EVIDENCE, CONSENSUS AND IMPLEMENTATION**

**Presenter: Stacey Miller, BC**

K. Mulpuri, BC, M. O'Donnell, BC

Hip displacement is the second most common musculoskeletal complication in children with cerebral palsy (CP). Displacement can worsen when left untreated, leading to more complex surgical treatment that has long-term impacts on quality of life. Formal programs in Europe and Australia have demonstrated the effectiveness of surveillance on prevention and management of hip dislocation. This evidence, combined with a high number of children presenting to our institution requiring salvage surgery, prompted us to develop the first formal provincial

hip surveillance program in North America. The purpose of the program is to ensure all children receive equitable, evidence-based care and reduce the need for complex hip reconstructive and salvage surgeries.

A group of 60 multi-disciplinary stakeholders including paediatric orthopaedic surgeons, paediatricians, general physicians, physiotherapists, health care professionals, policymakers and parents met over 1.5 days. Evidence regarding hip surveillance, including that of existing programs in Australia and Sweden, was reviewed and discussed. Consensus was established regarding terminology, commencement of surveillance, radiograph and clinical exam frequency, and discharge criteria for a provincial hip surveillance program. A second meeting was held to finalise the Consensus Statement and establish a model for implementation, knowledge translation and evaluation.

The Consensus Statement on Hip Surveillance for Children with CP was developed to establish the necessary frequency of clinical and radiological exams based on four patient groups divided by Gross Motor Function Classification System (GMFCS) levels: GMFCS level I-II; GMFCS level III; GMFCS level IV-V; and children with Winters, Gage and Hicks Type IV hemiplegia. The program has been launched province-wide; Two hundred and seventy-five children have been enrolled and are being followed with coordination between our institution and community health professionals. We developed a comprehensive knowledge translation strategy and materials including an e-learning module, booklets and posters for health professionals and parents. To support implementation, we completed a systematic review on interventions aimed to slow or prevent hip displacement in CP. The overall evidence level was low, with no treatment showing clinically significant effects.

Evidence-based group discussion with diverse stakeholder input enabled the development of a Consensus Statement and implementation plan. As the program progresses, we will evaluate the effectiveness of knowledge translation, adherence to the consensus statement and impact on child and family outcomes, particularly quality of life. This is the first formal province-wide program of hip surveillance for children with CP of its kind in North America.

#### **14. THE NEED FOR FURTHER CORRECTIVE SURGERY IN DEVELOPMENTAL DYSPLASIA OF THE HIP: SURGICAL DECISION-MAKING AND PRACTICE VARIABILITY**

**Presenter: Emily K. Schaeffer, BC**

K. Mulpuri, BC, C. Price, FL, A. Aroojis, India, N. Clarke, UK, W. Sankar, PA, Study Group IHDI, FL

Many studies on Developmental Dysplasia of the Hip (DDH) use the need for further corrective surgery (FCS) after primary treatment as an outcome representing treatment failure. However, the decision to proceed with, and timing of, FCS can be dependent upon surgeon preference. The purpose of this study was to capture variability in surgical decision-making regarding need for FCS after primary treatment for DDH.

Twenty cases consisting of patients previously treated for DDH were selected from the records of two paediatric orthopaedic surgeons practicing at different tertiary care hospitals. Demographic information, diagnosis, initial treatment(s) and serial radiographs were compiled and sent to international paediatric orthopaedic surgeons with a practice focus on the hip. For each case, surgeons were asked whether a surgical intervention would be necessary based on radiographs and radiographic measures, and if so, what intervention should be performed. Questions about reason for non-intervention and advanced imaging were also posed. Mean age of patients at time of query was 4.1 years (range 2.0-8.3).

Sixteen surgeons responded to the survey. On the decision for intervention, surgeons were unanimous in favour of intervention on 3/20 cases. Minimal consensus (eight for, eight against intervention) was seen in 3/20 cases. Average standardised consensus (zero to one) was 0.52, 95% CI [0.34-0.70]. When respondents felt an intervention was necessary, there was considerable variation in procedure choice. Most frequent procedures of choice were pelvic osteotomy (41%), combined pelvic and femoral osteotomy (24%) and femoral osteotomy alone (11%). Consensus did not correlate with patient age or length of follow-up since index procedure. When "no intervention" was selected, there was considerable variation in reasoning. "Likely to improve on own" was the most frequent reason selected (51%), then "Possible future intervention" (40%) and "Definite future intervention" (8%).

Surgical decision-making for FCS following DDH treatment is widely variable between surgeons. Provided the same series of radiographs and radiographic measures, 16 surgeons unanimously agreed whether or not an intervention was necessary on 15% of cases; and reached majority consensus on only 60% of cases. Further variation was seen in choice of procedure and timing of intervention. This international, cross-sectional survey demonstrates the inherent variability in DDH management practice for treating residual dysplasia between paediatric orthopaedic surgeons. This highlights the importance of caution when interpreting studies using FCS as a surrogate outcome measure. Recognition of this variability will aid in the identification of objective outcomes and provide a basis for consensus discussion.

### **15. FEMORAL NERVE PALSY IN BRACE TREATMENT FOR DEVELOPMENTAL DYSPLASIA OF THE HIP: INCIDENCE AND OUTCOMES IN A PROSPECTIVE INTERNATIONAL COHORT**

**Presenter: Emily K. Schaeffer, BC**

N. Clarke, UK, S. Kelley, ON, N. Williams, Australia, K. Mulpuri, BC, Study Group IHDI, FL

Femoral nerve palsy is a potential complication of brace treatment for developmental dysplasia of the hip (DDH). Previous attempts to establish the true incidence of this complication have largely been retrospective and/or included the entire DDH spectrum. The purpose of this study was to determine the incidence of femoral nerve palsy in a prospective cohort of infants with dislocated hips at rest treated by brace.

A multicentre, prospective database of infants diagnosed with dislocated hips at rest from 0-18 months of age was analysed from 2010-2016 for patients that developed femoral nerve palsy during brace treatment. Demographics, brace type, bracing length, secondary and definitive treatments were assessed. Radiographic parameters including acetabular angle and IHDI grade were also assessed.

In total, 27 patients (29 hips) developing femoral nerve palsy were identified from 456 infants with dislocated hips who underwent brace treatment for an overall incidence of 5.9%. Pavlik harness was used in 93% of cases. Patients were diagnosed and treated at an average age of 2.5 months (range zero-7.1); there were 23 female and four male patients. There were 15 unilateral left, six unilateral right and six bilateral patients, with 17 left hips and 12 right hips developing femoral nerve palsy. In total, 15/294 (5%) reducible hips and 12/99 (12%) irreducible hips were affected. Femoral nerve palsy presented after an average of 14.2 days in brace, and brace wear was immediately stopped in 24/27 cases. In 11 cases (10 Pavlik, one Rhino Cruiser), brace was abandoned and patients went on to open (seven) or closed (four) reduction. In six cases, reinstatement of the brace was attempted before open (three) or closed (three) reduction. The remaining 10 cases resolved with brace management.

Overall incidence of femoral nerve palsy in a prospective group of infants with dislocated hips treated by brace was 5.9%. Management choices were variable following presentation of femoral nerve palsy; three remained in brace, six returned to brace after symptom resolution, seven were switched to an alternative brace and 11 had bracing abandoned and proceeded to surgery. The incidence of femoral nerve palsy during brace treatment for DDH may be underestimated in patients with true dislocations, as previous studies include unstable or dysplastic hips. Ascertaining the success rate of brace treatment in these cases is extremely difficult and results must be interpreted with caution as management choice is a major determinant for definitive treatment method.

### **16. OPEN REDUCTION FOR DEVELOPMENTAL DYSPLASIA OF THE HIP: EARLY OUTCOMES FROM A MULTICENTRE, INTERNATIONAL PROSPECTIVE COHORT STUDY**

**Presenter: Travis Matheney, MA**

E.K. Schaeffer, BC, K. Mulpuri, BC, W. Sankar, PA, V. Upasani, CA, N. Clarke, UK, J. Herrera-Soto, FL, Y. Kim, MA, B. Foster, Australia, IHDI Study Group, FL

Open reduction (OR) is typically used in developmental dysplasia of the hip (DDH) to treat older infants, more severe dislocations, and dislocations that have failed closed reduction (CR). However, little data on outcomes and

complications of OR have been prospectively collected. The purpose of this observational, prospective multicentre study was to examine early outcomes and complications of OR.

A multicentre, prospective database of infants diagnosed with DDH 0-18 months of age was analysed from 2010 to 2015 for patients treated by OR. Demographics, clinical exam, radiographic/ultrasonographic data and history of previous orthosis or surgical treatment (CR) were assessed. At minimum one year follow-up, incidence of avascular necrosis (AVN, Salter criteria) and location of the femoral head (IHDI Grade) were assessed.

A total of 69 ORs (69 hips) were performed on 62 patients with a median age at diagnosis of eight months (range 0-18) and a median age at OR of 12 months (range 3-25). Acetabular and/or femoral osteotomies were concomitantly performed on 16 (23%) hips. Time between diagnosis and OR was three months (range 0-14). At diagnosis, 38/69 hips (55%) were irreducible, and 37/69 (54%) were left hips. At OR, 23/69 hips (33%) had received prior brace treatment and 18/69 hips (26%) had undergone CR. Pre-operatively, 41% of hips were IHDI Grade IV and mean pre-operative acetabular index (AI) was 39°. One hip required a second OR to reduce. At most recent follow-up (median 23 months, range 12-57), 60/69 hips (88%) were IHDI Grade I while 7/69 hips (11%) were IHDI Grade II. 18/69 hips (26%) developed AVN. AVN developed in 12/43 (28%) hips with an ossific nucleus at time of OR, and 6/26 (23%) hips without an ossific nucleus. During follow-up, 3/69 hips (4%) underwent further corrective surgery (FCS) for residual dysplasia.

At a median 23 months following OR, 99% of hips remained reduced; however, 11% had some degree of subluxation (IHDI Grade II). Development of AVN occurred in 26% of hips, and did not seem to be impacted by presence/absence of ossific nucleus. Early outcomes from this cohort suggest that OR is successful in achieving and maintaining hip reduction. However, AVN remains an important complication, and is comparable to the AVN rate found with closed reduction. Although numbers are too small to accurately assess risk factors for AVN, there appears to be no difference in AVN rate whether the ossific nucleus is present or absent.

## **17. PREDICTORS OF OSTEONECROSIS IN PAEDIATRIC FEMORAL NECK FRACTURES: EXPERIENCES FROM A TERTIARY PAEDIATRIC ACADEMIC CENTRE**

**Presenter: Tara Baxter, ON**

J. Daniel, IA, J. Stimek, ON, M. Camp, ON, A. Howard, ON

A retrospective analysis of patients who were treated for a femoral neck fracture between 2001 and 2014 at an academic level 1 paediatric trauma centre. The primary outcome was osteonecrosis based on radiographs, bone scan, or magnetic resonance imaging. Demographic information, injury details, treatment details, associated injuries, and outcomes were recorded. Exclusion criteria included pathological fracture or lack of clinical follow-up. Following univariate analysis, a logistic regression model was used to identify potential predictors of osteonecrosis following paediatric femoral neck fractures.

A retrospective analysis of patients who were treated for a femoral neck fracture between 2001 and 2014 at an academic level 1 paediatric trauma centre. The primary outcome was osteonecrosis based on radiographs, bone scan, or magnetic resonance imaging. Demographic information, injury details, treatment details, associated injuries, and outcomes were recorded. Exclusion criteria included pathological fracture or lack of clinical follow-up. Following univariate analysis, a logistic regression model was used to identify potential predictors of osteonecrosis following paediatric femoral neck fractures.

Fifty-eight femoral neck fractures were reviewed, with a mean age of 10 years (range, 1-17 y). Osteonecrosis occurred in 14 patients (24%). There were no significant differences in the occurrence of osteonecrosis based on age, fracture displacement, Delbet's classification, Pauwels' classification, reduction method (i.e. closed vs. open), or quality of reduction. A logistic regression model identified mechanism of injury and sex as significant predictors of osteonecrosis. The odds of developing osteonecrosis as a male were eight times those of a female ( $p=0.02$ , 95% CI, 1.4-50.1). Fractures resulting from high energy mechanisms had five times the odds of developing osteonecrosis ( $p=0.04$ , 95% CI, 1.1-50.1). Apart from osteonecrosis, other complications included nonunion (5%), coxa vara (7%), radiographic growth disturbance (5%), and leg-length

difference (2%). One patient underwent a fasciotomy on the contralateral side as a result of an extended period in the lithotomy positioning on the fracture table.

The prevalence of osteonecrosis following a paediatric femoral neck fracture was 24% in our series. Injury mechanism and sex were independently predictive of osteonecrosis development. Conversely, age, fracture classification, fracture displacement, reduction method and quality of reduction were not found to be significant risk factors for developing osteonecrosis. In conclusion, osteonecrosis is a potential complication following a paediatric femoral neck fracture. The etiology is likely multifactorial and factors unrelated to radiographic parameters and classifications appear to play a role. Awareness of predictive factors can help surgeons to better counsel patients and parents regarding the risk of osteonecrosis.

## **18. EARLY DEEP SURGICAL SITE INFECTION FOLLOWING 740 PRIMARY SINGLE-STAGE PAEDIATRIC SCOLIOSIS SURGERY: A MULTIVARIATE ANALYSIS OF RISK FACTORS**

**Presenter: Jerry Du, OH**

C. Poe-Kochert, OH, G. Thompson, OH, J. Son-Hing, OH, C. Hardesty, OH, R. Mistovich, OH

Deep surgical site infections following paediatric spinal deformity are a source of significant morbidity often requiring secondary surgery, which may affect surgical outcomes and result in additional burden to the healthcare system. Therefore, there is significant interest in identifying modifiable risk factors to decrease the risk of post-operative infections. We sought to identify independent risk factors for infection following primary single-stage paediatric scoliosis surgery.

Seven hundred and forty consecutive patients who underwent primary single-stage (posterior or anterior-posterior approach) scoliosis surgery from a single institution prospectively-maintained database were identified. Early deep surgical site infection was defined as infection within three months of index procedure requiring surgical intervention consistent with CDC guidelines. A multivariate analysis of demographic, co-morbidities, and perioperative factors was performed and independent risk factors were identified.

Fourteen patients (1.9%) developed early deep surgical site infection. Independent risk factors for early deep surgical site infection included non-idiopathic (congenital, neuromuscular, and syndromic) types of scoliosis (adjusted odds ratio [aOR]:8.387, 95% confidence interval [95% CI]: 1.818-38.701,  $p=0.006$ ) and amount of intra-operative crystalloids (aOR: 1.405 per additional litre of fluid, 95% CI: 1.003-1.968,  $p=0.048$ ). Average crystalloid in the infected group was  $3.3 \pm 1.2$  litres vs.  $2.5 \pm 1.1$  litres in the non-infected group ( $p=0.011$ ). There was no significant difference in weight of patients between cohorts on univariate analysis ( $p=0.730$ ). However, the infected group had a significantly higher operative time for posterior fusion on univariate analysis ( $391.7 \pm 100.0$  minutes vs.  $332.0 \pm 86.7$  minutes,  $p=.011$ ). Presence of a ventriculo-peritoneal shunt ( $p=0.020$ ), pelvic extension of the fusion construct ( $p=0.001$ ), and increased operative time ( $p=.011$ ) were significant risk factors on univariate analysis. Differences in BMI ( $p=0.282$ ) and implant material ( $p=0.410$ ) were not significant risk factors by univariate analysis. Re-dosing of antibiotics intra-operatively after three hours of surgery trended on significance as a risk factor (odds ratio: 0.356, 95% CI: 0.098-1.286,  $p=0.111$ ).

Non-idiopathic scoliosis and amount of intra-operative crystalloids were identified as independent risk factors for early post-operative deep surgical site infection. Intra-operative fluid management may present as a modifiable risk factor for early deep surgical site infection. Further investigation into the impact of intra-operative re-dosing of antibiotics on early deep surgical site infection should be performed.

## **19. SURGICAL SITE INFECTION PREVENTION PROTOCOL FOR PAEDIATRIC SPINAL DEFORMITY SURGERY: DOES IT MAKE A DIFFERENCE?**

**Presenter: Jochen P. Son-Hing, OH**

C. Poe-Kochert, OH, R.J. Mistovich, OH, C. Hardesty, OH, G. Thompson, OH

Surgical site infection (SSI) is a major concern in paediatric spinal deformity surgery. Can the use of a standardised, hospital-wide care bundle result in a decreased infection rate?

Using our institutional review board-approved Paediatric Orthopaedic Spine Database, we performed a retrospective review of our primary scoliosis surgeries between 2001 and 2014. In 2008, we implemented a comprehensive standardised infection reduction bundle. Interventions included pre-operative nares screening for Methicillin-resistant *Staphylococcus aureus* (MRSA) and treatment with intranasal mupirocin when positive, a pre-operative chlorohexidine scrub, timing of standardised antibiotic administration, standardised intra-operative re-dosing of antibiotics, limiting OR traffic, and standardised post-operative wound care. Our inclusion criteria were patients 21 years of age or less who carried a diagnosis of idiopathic, neuromuscular, syndromic, and congenital scoliosis who had undergone posterior spinal fusion with segmental spinal instrumentation of six levels or more, and a minimum of one year post-operative follow-up. We excluded staged procedures, anterior only procedures, growing rod procedures, and instrumentation of five levels or less. We compared the incidence of early (within 90 days of surgery) and late (>91 days) wound infections before these interventions.

There were 661 patients who met inclusion criteria: 334 in Group 1 (2001-2007) and 327 in Group 2 (2008-2014). Due to the large number of patients, the pre-operative, intra-operative, and post-operative demographics of both groups were essentially identical. Post-operatively, there were 21 infections (6.3%) in Group 1: nine early (2.7%) and 12 late (3.6%) while there were only eight infections (2.4%) in Group 2: four early (1.2%) and four late (1.2%). The reduction in overall SSIs was statistically significant ( $p=0.01$ ). There was a trend toward decreased infection rate for early infections, but this did not reach statistical significance ( $p=0.14$ ). The rates of SSI are further subcategorised in Table 1 both before and after implementation of our prevention protocol.

Our infection reduction bundle demonstrated a statistically significant reduction in all infections. While there was a trend toward decreased SSI for early infections, this did not reach statistical significance. This is attributed to our relatively low numbers of infections in both groups. Standardised care bundles are effective in reducing the incidence of post-operative paediatric spine SSIs. The authors advocate for well-designed, multicentre studies to determine the efficacy of individual interventions of our infection reduction bundle.

## **CORS Arthroplasty**

### **20. EVOLUTION OF CORROSION PARTICLES AT THE HEAD-NECK INTERFACE IN HIP IMPLANTS - HOW METALS ARE RELEASED *IN VIVO*?**

**Presenter: Qiong Wang, BC**

R. Wang, BC

Adverse local tissue reaction (ALTR) associated with metal release as a result of fretting corrosion at modular interfaces (i.e. head-neck interface) is the major reason for revision in modular total hip replacements (THR). The formation of corrosion particles at the head-neck interface and their migration from the interface to synovial fluid are crucial processes of metal release. Studying the evolution of corrosion particles could help us understand how metallic elements are released *in vivo* and cause the adverse local tissue reaction. The purpose of this study is to investigate the *in vivo* metal release processes *via* the analysis of the chemical nature of corrosion particles at different locations of head-neck interface from modular total hip implants revision.

Methods: Seventeen retrieved implants with evident corrosion at head-neck interface (CoCrMo femoral head with Ti alloy stem neck) were analysed ( $n=17$ ). Corrosion particles at two specific locations with different local environments were analysed and compared. One was inside the interface where direct fretting corrosion happened. The other was at the opening site of the interface where no direct fretting corrosion happened and corrosion particles had direct contact with the synovial fluid.

Corrosion products inside head-neck interface were clusters of nano-sized crystals mainly consisting of Cr (III) and Mo (IV, VI) with depleted Co. The concentration of Mo with respect to Cr in these corrosion particles was higher than CoCrMo alloy ( $n=17$ ). It indicated a faster dissolution of Cr compared to Mo during the formation of fretting corrosion particles. At the opening site with access to synovial fluid, amorphous particles mainly containing Cr (III), PO<sub>4</sub> (phosphate group) with significantly lower Mo ( $n=16$ ) and higher Co ( $n=14$ ) were detected

compared to those inside the interface. This change suggested that Mo was released further and some Co precipitated when corrosion particles were in contact with synovial fluid.

Our study revealed *in vivo* release process of metallic elements from artificial hip joints, from formation to migration. When fretting corrosion happened between CoCrMo femoral head and Ti stem neck, Co was largely released and Cr was released faster than Mo, resulting in the formation of nano-sized corrosion particles. When these particles migrated into the opening site in contact with synovial fluid, corrosion particles became amorphous with additional P, reduced Mo and slightly increased Co. It suggested that Mo was further released when corrosion particles interacted with synovial fluid. Such a progressive release process was probably caused by the different local electrochemical factors (such as pH, oxygen concentration, protein concentration, etc.) between locations inside the head-neck interface and at the opening site in contact with synovial fluid.

## **21. SUBJECT AND IMPLANT FACTORS AFFECTING TIBIAL COMPONENT MIGRATION IN TOTAL KNEE ARTHROPLASTY**

**Presenter: Elise Laende, NS**

J. Flemming, NS, J.A. Wilson, NS, G. Richardson, NS, M. Dunbar, NS

Predictive models of long-term implant fixation in total knee arthroplasty (TKA) based on radiostereometric analysis (RSA) data have traditionally ignored the effects of patient demographics and implant factors which may influence the pattern and magnitude of implant migration. The objective of this analysis was to determine which implant and subject factors influenced overall migration of tibial components following TKA.

Data were compiled from a registry of RSA data on primary TKAs ( $n = 367$ ). Of this overall group, 222 implants were cemented and 145 uncemented in 153 male subjects and 214 female subjects. All subjects had a primary diagnosis of osteoarthritis and had RSA examinations over two years. No implants were revised during follow-up. Longitudinal data analysis using marginal models was performed to examine the influence of demographic and implant covariates while accounting for repeated measures of implant migration over time. Implant fixation (cemented or uncemented), age, sex, BMI, implant size, and smoking status were included in the model. Analyses were also performed on sub-groups of sex and implant fixation.

In the overall group, only implant fixation had a significant effect on implant migration ( $p < 0.001$ ). For uncemented tibial components in male subjects, smoking was significant ( $p = 0.01$ ) and in the uncemented females group smoking ( $p = 0.04$ ) and age ( $p = 0.02$ ) affected implant migration. The effect of smoking in uncemented male subjects was to reduce the overall migration, while in female uncemented subjects the effect was reversed. Increasing age in uncemented females was associated with high implant migrations. For cemented implants, no covariates were significant.

The migration of uncemented tibial components is more sensitive to subject factors than cemented implants. These differences are not consistent by sex, suggesting that it may be of value to evaluate male and female subjects separately following TKA.

## **22. KINEMATIC ANALYSIS OF DUAL-MOBILITY VS. SINGLE-BEARING HIP PROSTHESIS DURING SQUATTING TASK USING STATISTICAL PARAMETRIC MAPPING**

**Presenter: Mario Lamontagne, ON**

E. Kowalski, ON, D. Catelli, ON, P.E. Beaulé, ON

Total Hip Arthroplasty (THA) using a dual mobility (DM) design minimises the risks of dislocation and impingement, permitting a larger range of motion of the hip. However, it is still unclear whether it would lead to improved functional mobility. The purpose was to analyse if DM implants results in better pelvis, hip and knee joint kinematics improvement than with a SB (single bearing) implant during a squatting task.

Twenty-four patients were prospectively randomised to either a DM design or SB component and were matched by age and body mass index to 12 healthy participants (CTRL). All surgeries were performed by the same surgeon using the direct anterior approach. Motion analysis was done pre-operatively and nine months

post-operatively to measure joint kinematics and maximal squat depths during squatting trials. Joint kinematics were compared using statistical parametric mapping (SPM), using a one-way ANOVA with a Bonferroni post hoc comparison to determine where significant differences occurred (CI = 95%).

At the pelvis, DM and SB implants were significantly different from one another in the first 12% of the squat descent phase, and no other differences were observed in the remainder of the squat. When comparing against the CTRL, the DM implant had closer pelvic kinematics to the healthy subjects. At the hip joint, no differences existed between DM and SB implants; and both groups remained significantly different from CTRL. At the knee joint, DM and SB implants were significantly different from one another in the second half of the ascent phase. The SB implant has closer knee kinematics to the CTRL during the first half of the descending phase and second half of the ascending phase than the DM implant. Squat depths showed no improvements between pre- and post-operative conditions with either implant and none of the groups could achieve as deep of a squat depth as the CTRL group post-operatively.

Our findings are in line with previous motion analysis studies which determined that joint kinematics do not return to the level of controls following THA. Pelvis mobility improved more with the DM implant than the SB implant, but only when compared to the CTRL group. Although the DM implant design offers greater mobility, patients are unable to take advantage of this to achieve a greater squat depth than those implanted with an SB implant. We believe that this is due to soft-tissue tightness creating a barrier which is preventing further mobility. Post-THA rehabilitation should focus on improving hip joint mobility and strength.

### **23. HUMERAL LATERALISATION OPTIMISES TENDON TRANSFER STRENGTH AFTER REVERSE SHOULDER ARTHROPLASTY**

**Presenter: G. Daniel G. Langohr, ON**

K. Chan, ON, M. Mahaffy, ON, J. Johnson, ON, G. Athwal, ON

Reverse total shoulder arthroplasty (RTSA) is effective in restoring active forward elevation, although restoration of active rotation with severe cuff deficiency is unpredictable. In patients with an absent posterior cuff, a latissimus tendon transfer done concurrently with RTSA has been described. Commercially available RTSA implants have varying humeral component offsets, and some newer designs permit adjustment of this implant parameter. This study aimed to determine the effect of altering RTSA humeral component offset on the effectiveness of tendon transfers to maximise rotational strengths. We hypothesised that increasing humeral component lateralisation would increase tendon transfer strengths.

Seven fresh-frozen cadaveric shoulders (mean age 74 yrs) underwent RTSA with an implant that permitted adjustment of humeral lateralisation (-5, 0, 5, 10, 15 mm). All rotator cuff muscles were released and latissimus dorsi, and lower trapezius tendon transfers were compared for active external rotation (ER) restoration. The pectorialis major tendon transfer was assessed for internal rotation (IR) restoration. The shoulders were attached to a shoulder simulator and IR & ER strengths were measured for each lateralisation at varying elevation (0°, 45°, 90°) and IR/ER (0°, ±30°, ±60°) angles.

The trapezius transfer was, on average, 1.6±0.2 Nm stronger than the latissimus transfer (p<0.001). The IR and ER strengths of all tendon transfers decreased as abduction increased (p<0.01). At 0±730; elevation, humeral lateralisation had a significant effect on tendon transfer strength at 60±730; IR and ER (Figure 1, p<0.05). At 60±730; IR, humeral lateralisation of +15mm decreased the ER strength of the trapezius transfer by 59±30% (p=0.003), and increased the IR strength of the pectoralis major transfer by 76±40% (p<0.001). At 60±730; ER, humeral lateralisation of +15mm increased the ER strength of the trapezius and latissimus transfer by 18±22% and 28±30% respectively (p=0.004 and p=0.04), and decreased the IR strength of the pectoralis major transfer by 11±16% (p=0.56).

RTSA humeral lateralisation significantly improved tendon transfer muscle strength in the cuff deficient shoulder. To restore active ER, the lower trapezius was significantly stronger than the latissimus dorsi, however, both tendon transfers were optimised with humeral offset. Additionally, the pectoralis major transfer was effective in restoring IR strength. Humeral lateralisation is a promising implant parameter to optimise RTSA biomechanics.



Further investigations are needed to determine the clinical effects of humeral lateralisation on functional outcomes and range of motion.

#### **24. THE EFFECT OF ARM LOADING AND PLANE OF ELEVATION ON ACROMIAL STRESS AFTER REVERSE SHOULDER ARTHROPLASTY**

**Presenter: Jason S. Lockhart, ON**

M. Wong, ON, G.D.G. Langohr, ON, G. Athwal, ON, J. Johnson, ON

Acromial fractures are a significant complication after reverse shoulder arthroplasty, and have been reported to affect up to 7% of patients. Previous studies have sought to better understand these fractures, and it has been shown that implant placement affects acromial stress during elevation of the arm in the scaption plane (0-120°). The purpose of this study was to investigate the result of increased arm loading, as well as variation of the plane of elevation.

A mathematical model was used to calculate the forces in seven deltoid segments required to achieve static humeral positioning at nine elevation angles (0-120°), in three planes of elevation (60° forward elevation, 30° forward elevation (scaption), and 0°), and three hand loads (0, 2.5, 5kg). The resulting deltoid forces were then applied to the acromion at the deltoid origin points in a finite element model (ABAQUS). Bone geometry was generated using CT data from 10 cadaveric shoulders (68±19 yrs), and material properties were assigned based on CT attenuation. The results were analysed using an RM ANOVA.

Compared to the 30° scaption plane, abducting the humerus in the 0° plane of elevation resulted in an increase in peak acromial stress of 57.8±3.0% (p=0.002), whereas abducting in the 60° plane of elevation decreased peak acromial stress by 9.7±26% (p=0.28). Increasing hand load from zero to five kg in the scaption plane increased mean acromial stress by 109.3±3.9% compared to the unloaded state (p<0.001). During abduction in the 0±730; plane of elevation, increasing hand load from zero to five kg increased the mean acromial stress by 102.2±6.0% compared to the unloaded state (p<0.001). Increasing hand loading in the 60±730; plane of elevation increased the mean acromial stress by 97.8±13.5% compared to the unloaded state (p<0.001). For all planes of elevation and hand loads investigated, glenoid lateralisation consistently increased acromial stress, glenoid inferiorisation consistently decreased acromial stress, and both humeral medialisation and lateralisation proved to be insignificant in altering acromial stress.

The results of this study show that humeral abduction in 60° of forward elevation produces lower acromial stresses than abduction in the coronal plane. Increasing hand load increased acromial stresses for all planes of elevation investigated, likely a result of the larger deltoid forces required to maintain static positioning of the humerus when loading is applied. Medial and inferior positioning of the glenoid has a positive effect on acromial stress that scales linearly as load is increased. Additionally, humeral positioning, both lateral and medial, had no significant effect on acromial stress for a variety of planes of elevation and hand loads. These results suggest that inferior glenosphere positioning instead of a lateralised position decreases the risk of acromial fracture.

#### **25. DIFFERENTIALLY REPRESENTED PROTEINS IN THE SYNOVIAL FLUID OF HIP ARTHROPLASTY PATIENTS WITH A PSEUDOTUMOUR VS. PERIPROSTHETIC OSTEOLYSIS**

**Presenter: Isabella Catelas, ON**

E. Lehoux, ON, Z. Ning, ON, D. Figeys, ON, S. Baskey, ON, P.E. Beaulé, ON

The identification of specific proteins in the synovial fluid (SF) of patients with a failed metal-on-metal (MoM) hip implant associated with a pseudotumour may lead to a better understanding of the pathomechanisms underlying metal-related pseudotumours. The objective of this study was to identify differentially abundant proteins in the SF of patients with a short-term MoM hip implant associated with a pseudotumour and patients with a long-term metal-on-polyethylene (MoPE) hip implant associated with periprosthetic osteolysis.

This research has been approved by our local research ethics board. SF was collected by arthrocentesis from patients with a short-term MoM hip implant associated with a pseudotumour (one male and five females, 62

± 10 years old, mean time to failure  $4.0 \pm 1.6$  years) and a long-term MoPE hip implant associated with periprosthetic osteolysis (one male and five females,  $73 \pm 10$  years old, mean time to failure  $16.2 \pm 6.4$  years). Shotgun proteomics was used to identify differentially abundant proteins in albumin-depleted SF. Statistical analysis was performed using a two-sided t-test and the significance B test with  $p < 0.5$  considered significant.

In toto, 452 distinct proteins were identified in at least half of the patients of at least one patient group, and 30 of these proteins were differentially abundant between the two groups. 6-Phosphogluconate dehydrogenase had an absolute specificity and sensitivity for the MoM group and may therefore be a potential biomarker of metal-related pseudotumours. A greater number of differentially abundant proteins involved in the adaptive immune response were present in the MoM group, including proteins involved in type-IV hypersensitivity. Differentially abundant proteins involved in necrosis were identified exclusively in the MoM group. Furthermore, a greater number of differentially abundant cytoplasmic proteins (likely released by necrosis) were detected in the MoM group. Finally, differentially abundant proteins involved in the innate immune response, oxidative stress, apoptosis, and tissue remodelling were identified in both patient groups.

Overall, results suggest the presence of a type-IV hypersensitivity reaction as well as necrosis in the MoM group. Results also suggest the presence of an innate immune response, oxidative stress, apoptosis, and tissue remodelling in both patient groups, with potential differences in the pathomechanisms. More specifically, the specificity and sensitivity for the MoM group of 6-phosphogluconate dehydrogenase, an enzyme that plays a key role in the protection against oxidative stress, suggests the presence of greater oxidative stress. Finally, the differentially abundant proteins involved in tissue remodelling suggest greater vascular changes in the MoM group. Overall, the differentially abundant proteins identified may ultimately help elucidate the etiology of pseudotumours and assess their risk of developing into an aggressive lesion.

## **26. CONTACT KINEMATICS CORRELATE TO TIBIAL COMPONENT MIGRATION FOLLOWING SINGLE RADIUS POSTERIOR STABILISED KNEE REPLACEMENT**

**Presenter: Matthew G. Teeter, ON**

K. Perry, MN, X. Yuan, ON, J. Howard, ON, B. Lanting, ON

Surgical technique for soft tissue balancing during total knee replacement has become hotly debated, with surgeons prioritising either bony resections or soft tissue releases. Previous studies have found a greater rate of coronal instability and femoral component liftoff from using certain tissue balancing techniques, but it is unknown how potential differences in loading due to condylar liftoff translate into component stability and fixation.

Patients were randomly assigned at the time of referral to a surgeon performing either a gap balancing or measured resection technique for soft tissue balancing ( $n=12$  knees per group). Both groups received an identical cemented, posterior-stabilised implant with a single radius design. At the time of surgery, marker beads were inserted in the bone around the implants to enable radiostereometric analysis (RSA) imaging. Patients underwent supine RSA exams at zero to two weeks, six weeks, three months, six months, and 12 months, and standing exams with their knees flexed at zero, 20, 40, and 60 degrees at 12 months. Migration and contact locations of the tibial and femoral components were calculated using model-based RSA software. Condylar liftoff and the location of contact was correlated to migration.

There were no revisions or adverse events. The greatest amount of liftoff at any flexion angle correlated with anterior-posterior tilt ( $r=-0.56$ ,  $p=0.01$ ) and varus-valgus tilt ( $r=-0.60$ ,  $p<0.01$ ) of the tibial component. The location of the most anterior and posterior contact points on the medial and lateral condyles were also correlated with anterior-posterior tilt ( $r=0.68$ ,  $p=0.001$ ), varus-valgus tilt ( $r=0.51$ ,  $p=0.02$ ), and anterior-posterior translation ( $r=0.52$ ,  $p=0.02$ ). Maximum total point motion (MTPM) of the tibial component was not different ( $p=0.82$ ) at one year between patients with condylar liftoff above 0.5mm ( $0.69 \pm 0.34$ mm) and patients without liftoff ( $0.66 \pm 0.22$ mm).

Greater condylar liftoff and more anterior or posterior contact correlate with tibial component migration at one year, following a migration pattern likely related to loading. With lateral liftoff, all force is translated through the medial condyle, and this appears to rotate the tibial component towards a more varus alignment. The opposite

occurs with medial liftoff. In all cases, the magnitude of the migrations is within the accepted safe range for predicted long-term implant fixation.

## **27. THE EFFECTS OF HUMERAL LATERALISATION ON ROTATOR CUFF STRENGTH AFTER REVERSE SHOULDER ARTHROPLASTY**

**Presenter: Kevin Chan, ON**

G.D.G.Langohr, ON, M. Mahaffy, ON, J. Johnson, ON, G. Athwal, ON

Reverse total shoulder arthroplasty (RTSA) is a widely used surgical treatment option for symptomatic cuff tear arthropathy. However, the particular implant design parameters that lead to optimised outcomes, such as range of motion and muscle strength, have yet to be determined. As such, the purpose of this biomechanical simulator study was to determine the effects of humeral component lateralisation on rotator cuff strength/torque (the ability of the cuff to rotate the humerus). We hypothesised that increasing humeral component lateralisation would place the rotator cuff at a biomechanical advantage, which would maximise muscle strength.

Seven fresh-frozen cadaveric shoulders ( $74 \pm 8$  yrs) were tested using an *in vitro* simulator. A custom RTSA was implanted that allowed five different humeral component lateralisations (-5, 0, 5, 10, 15mm). The torques exerted by the anterior and posterior rotator cuff were measured for varying humeral lateralisations, abduction angles ( $0^\circ$ ,  $45^\circ$ ,  $90^\circ$ ), and internal/external rotations ( $-60^\circ$ ,  $-30^\circ$ ,  $0^\circ$ ,  $30^\circ$ ,  $60^\circ$ ).

As shoulder abduction increased, the anterior and posterior cuff strengths significantly decreased ( $p < 0.01$ ). With the arm at side ( $0^\circ$  abduction), humeral lateralisation had a significant effect on the anterior and posterior cuff strength, particularly in terminal rotation positions ( $p < 0.001$ ) (Figure 1). Specifically, in  $60^\circ$  of external rotation (ER), the posterior cuff strength increased from  $6.2 \pm 1.5$  Nm at -5 mm humeral lateralisation to  $8.2 \pm 1.3$  Nm at +15 mm humeral lateralisation ( $p = 0.008$ ). Similarly, in  $60^\circ$  of internal rotation, the anterior cuff strength increased from  $6.4 \pm 1.6$  Nm at -5 mm humeral lateralisation to  $9.6 \pm 1.7$  Nm at +15mm humeral lateralisation ( $p = 0.001$ ).

Humeral lateralisation improved rotator cuff muscle strength, particularly when the glenohumeral joint is positioned in external rotation for the posterior cuff and internal rotation for the anterior cuff. Humeral lateralisation is a promising implant parameter to optimise RTSA biomechanics; however, further investigations are needed to determine if any potential negative effects exist.

## **28 - INFERIOR GLENOSPHERE TILT IMPROVES REVERSE SHOULDER ARTHROPLASTY CONTACT MECHANICS**

**Presenter: Michael Griffiths, ON,**

G.D.G. Langohr, ON, G. Athwal, ON, J. Johnson, ON

Reverse total shoulder arthroplasty (RTSA) is an effective treatment for rotator cuff tear arthropathy. However, scapular notching can occur, which may impact implant longevity. Inferior tilt of the glenosphere may help reduce the chance of scapular notching, although the implications of this on the contact mechanics of the articulation have not been fully investigated. The purpose of the present study was to evaluate the effect of glenosphere tilt on the contact mechanics of RTSA prostheses during abduction.

Finite element models of RTSA prostheses were developed in Abaqus (V6.12; Simulia), wherein the glenosphere had a diameter of 38 mm and was assigned cobalt-chrome material properties ( $E = 210$  GPa,  $\nu = 0.3$ ). The humeral cup component was assigned ultra-high-molecular-weight polyethylene (UHMWPE) material properties ( $E = 650$  MPa,  $\nu = 0.44$ ). Both components were meshed using linear hexahedral elements with an approximate average side length of 0.3 mm, found to be suitable through a mesh convergence study. A joint load of 400 N was applied at physiologically relevant angles for the given angle of abduction, based on reported values. Simulations were conducted for each combination of neck-shaft angles ( $135^\circ$ ,  $145^\circ$ ,  $155^\circ$ ), angle of abduction ( $15$ - $120^\circ$  at  $15^\circ$  intervals), and angle of glenosphere tilt ( $15^\circ$ ,  $10^\circ$ , and  $5^\circ$  inferior, neutral, and  $5^\circ$  superior), with the contact area and maximum contact stress in the UHMWPE humeral cup being obtained.

As glenosphere inferior tilt was increased from neutral, contact area increased, with a 6%, 27%, and 37% increase for the 135°, 145°, and 155° neck-shaft angles respectively for a 15° inferior tilt positioned in 15° abduction. Increasing glenosphere inferior tilt reduced maximum contact stress, with a 3%, 32%, and 48% reduction for the 135°, 145°, and 155° neck-shaft angles respectively with a 15° inferior tilt positioned in 15° abduction. Conversely, a superior tilt of 5° increased maximum contact stress and decreased articular contact area. These effects for both superior and inferior glenosphere tilt were primarily observed at low angles of abduction, and were more apparent with increasing inferior glenosphere tilt. As neck-shaft angle was reduced, increasing glenosphere tilt had reduced impact on articular contact mechanics.

Inferior glenosphere tilt increased contact area and decreased maximum contact stress at low angles of abduction, while superior tilt was found to have the opposite effect. Reducing neck-shaft angle reduced the positive effect of glenosphere tilt, likely a result of the lack of inferomedial cup overhang behind the medial plane of the glenosphere for the lower neck-shaft angle models. Further studies are required to further understand the impact that inferior glenosphere tilt has on the biomechanics and functionality of RTSA systems.

## **COA/CORS Spine**

### **29. A SIMPLIFIED CLINICAL PREDICTION RULE FOR PROGNOSTICATING INDEPENDENT WALKING AFTER SPINAL CORD INJURY: A PROSPECTIVE STUDY FROM A CANADIAN MULTICENTRE SPINAL CORD INJURY REGISTRY**

**Presenter: Katie Emily Hicks, ON**

P. Phan, ON, N. Attabib, NB, N. Fallah, BC, T. Marion, BC, V. Noonan, BC, J. Paquet, QC, T. Plashkes, BC, C. Rivers, BC, D. Roffey, BC, E. Tsai, ON, E. Wai, ON, Y. Zhao, BC, H. Ahn, ON

To re-validate an existing clinical prediction model for independent ambulation (van Middendorp et al. 2011) utilising acute and long-term post-injury follow-up data, and to investigate the accuracy of a simplified model using prospectively collected data from a Canadian multicentre SCI database, the Rick Hansen Spinal Cord Injury Registry (RHSCIR).

Acute (zero to 15 days) and long-term follow-up ( $\geq 12$  months) data was extracted from the RHSCIR, including participant data from participating centres nationwide. Individuals were eligible to participate if they were at least 18 years old at the time of SCI, had no previous history of SCI or laminectomy, and had a neurological examination within the first 15 days post-injury. The first FIM locomotion assessment that was available  $\geq 12$  months post-injury was used as the outcome measure for independent ambulation. A previously established logistic regression (LR) model based on age and four neurological variables was applied to our cohort of 278 RHSCIR participants. These prognostic variables were: age (dichotomised at 65 years old), motor scores of the quadriceps femoris (L3) and gastrocnemius (S1) muscles, and light touch sensation of the corresponding L3 and S1 dermatomes. Additionally, a simplified LR model was created. The Hosmer-Lemeshow goodness of fit-test was used to check if the predictive model is applicable to our data set. The performance of the model was verified by calculating the area under the receiver operating characteristic curve (AUC). The accuracy of the model was tested using a cross-validation technique.

The fitted prediction model generated 85% overall classification accuracy, 79% sensitivity and 90% specificity. The prediction model was able to accurately classify independent walking ability (AUC 0.889, 95% CI 0.846-0.933,  $p < 0.001$ ) compared to the existing prediction model, despite the use of a different outcome measure (FIM vs. SCIM) to qualify walking ability. A simplified, three-variable LR model based on age and two neurological variables had an overall classification accuracy of 84% with 76% sensitivity and 90% specificity, demonstrating comparable accuracy to its five-variable prediction model counterpart. The AUC was 0.866 (95% CI 0.816-0.916,  $p < 0.01$ ), only marginally less than that of the existing prediction model.

This study demonstrates external validity in Canada of the clinical prediction model developed by van Middendorp et al., and provides further evidence of the transportability of the model, as previously demonstrated in datasets from the U.S. and Australia. Furthermore, a simplified predictive model with similar accuracy to a more

complex model for predicting independent walking was created. Such models will allow clinicians to better predict the prognosis of ambulation in individuals who have sustained a traumatic SCI, aiding in the treatment, management of patient expectations, and optimisation of rehabilitation goals and community re-integration plans.

### **30. PREDICTORS OF BLOOD TRANSFUSION IN POSTERIOR LUMBAR SPINAL FUSION: A CANADIAN SPINE OUTCOME AND RESEARCH NETWORK (CSORN) STUDY**

**Presenter: Mina Morcos, QC**

F. Jiang, QC, G. McIntosh, ON, M. Weber, QC

The rate of posterior lumbar spinal fusion (PSF) surgery has increased significantly over the past few years. It remains the most common surgical procedure used to stabilise the spine for a variety of spinal pathologies; however, the impact of blood loss requiring blood transfusions remain a significant concern in this population. The purpose of this study was to identify patient related, disease related or procedure related predictors of post-operative blood transfusions.

This is an ambispective analysis of data from the Canadian Spine Outcomes and Research Network (CSORN). Patients who underwent PSF between 2008 and 2015 were identified. Multivariate analysis was used to identify predictors of blood transfusion from routinely collected patient information including both pre-operative and intra-operative items.

Of the 772 patients identified to have undergone PSF, 18% required blood transfusion. Overall, there were 54.8% females and the mean age was 60 years.

Multivariable logistic regression analysis revealed five significant predictors of blood transfusion: American Society of Anesthesiologist class (ASA), operative time, number of level fused, sacrum involvement and open posterior approach. The odds of transfusion for those with ASA class greater than 1 were six times the odds for those with ASA class 1 (OR 6.1, 95% CI 1.4-27.1,  $p < 0.018$ ). For each 60 minutes increase in operating room time, the odds of transfusion increased by 4.2% (OR 1.007, 95% CI 1.004-1.009,  $p < 0.001$ ). Moreover, the odds of transfusion when more than one level were fused was 6 times the odds for one level fusion (OR 5.8, 95% CI 2.6-13.2,  $p < 0.001$ ). Also, when the fusion was extended to the sacrum the odds for blood transfusion were three times higher (OR 3.2, 95% CI 1.8-5.8,  $p < 0.001$ ). Finally, the odds of transfusion for patients undergoing open posterior approach were 12 times the odds for those who had minimal invasive surgery (OR 12.5, 95% CI 1.6-97.4,  $p < 0.016$ ). In addition, patients receiving transfusions who underwent lumbar fusion were more likely to have extended hospital stay.

ASA > 1, prolonged operative time, multilevel fusion surgery, sacrum involvement and open posterior approach were significant predictors of blood transfusion in posterior lumbar spinal fusion.

### **31. PREDICTORS OF DISCHARGE TO HOME AFTER POSTERIOR LUMBAR SPINAL FUSION. AN ANALYSIS OF CANADIAN SPINE OUTCOMES AND RESEARCH NETWORK DATABASE**

**Presenter: Mina Morcos, QC**

F. Jiang, QC, A. Munteau, QC, G. McIntosh, ON, M. Weber, QC

Spinal fusion is one of the common spine procedures performed for a variety of spinal pathologies as well one of the more expensive. Post-operatively, certain patients are unable to be discharged directly to their home and often require prolonged hospital stays while waiting for a bed at a short-term care facility. As population demographics shift towards the more elderly in North America, healthcare systems would benefit from an effective method to maintain the quality of care while reducing expenditures. The ability to predict patient discharge destination could be one such method as hospital stays may be reduced by improved discharge planning. Currently, little evidence exists in the literature for predictors of discharge destination in these patients. The objective of this study was to identify predictive factors for patients discharged to home following posterior lumbar spinal fusion.

Six hundred and forty-three patients that underwent lumbar spinal fusion between 2008 and 2015 were retrospectively identified using the Canadian Spine Outcomes and Research Network database. Patient characteristics and operative factors were collected from the database. Outcome measures were identified as discharge destination to either home or non-home facilities. Multivariate analysis was used to determine if the identified patient characteristics and operative factors would be a predictive factor for discharge to home.

Of the 643 patients included in the study, the majority (N=560, 87.1%) were discharged home after lumbar spinal fusion and a minority of the patients required discharge to other facilities (N=83, 12.9%). Multivariate logistic regression analysis identified several significant patient factors as predictive for discharge to home including younger age, low BMI, low ODI score and pre-operatively not living alone. Operative factors found to be significant predictors were: reduced operating time, reduced number of operated levels, and absence of blood transfusion during the hospital stay.

Significant patient and operative predictors for discharge to home following lumbar spinal fusion were identified using the Canadian Spine Outcomes and Research Network database. Understanding these predictive factors allows initial screening of patients at risk. This enables early implementation of an algorithm to possibly decrease the length of hospital stay by early involvement of services for discharge planning to short-term care facilities and thus reducing hospital costs and expenditures.

### **33. ASSESSMENT OF VERTEBRAL ROTATIONAL ORIENTATION USING EOS IMAGING TECHNOLOGY IN INSTRUMENTED SPINES OF PATIENTS WITH ADOLESCENT IDIOPATHIC SCOLIOSIS**

**Presenter: Fan Jiang, QC**

L. Simoes, Brazil, J. Ouellet, QC, N. Saran, QC

EOS 3D imaging technology is a new low dose radiation imaging modality capable of performing simultaneous orthogonal views of the spine in an upright position and allowing quantification of global and intersegmental changes using 3D reconstruction. It has demonstrated good image quality, structural visibility, and accuracy comparable to conventional radiographs for curve magnitude and spinopelvic measurements. The validity and reliability of EOS in the analysis of the vertebral shape and orientation has been shown to be similar to that of computed tomography (CT) in the non-instrumented spine. The objective of this study was to assess the validity of EOS in the determination of vertebral rotational orientation in the instrumented spine.

Retrospectively 31 adolescent patients with the diagnosis of adolescent idiopathic scoliosis (AIS) who had a previous posterior spinal instrumented fusion were identified. Each had a EOS imaging as well as a CT scan of the spine within a six month period. EOS 3D models of the spine were generated for each patient, and the vertebral rotations were determined from the analysis for the apex vertebra, the uppermost (UIV) and lowermost (LIV) instrumented vertebra, the non-instrumented vertebra one level cranial to the UIV (UIV+1) and one level caudal to LIV (LIV +1). The same vertebral level orientations were measured using CT axial images. To account for patient positions during the imaging process, the relative vertebral rotation changes were calculated for the UIV to apex, UIV+1 to apex, LIV to apex, LIV+1 to apex, UIV to LIV and UIV+1 to LIV+1 for both imaging modalities. Comparison of the relative vertebral rotation changes for the levels specified was done using paired t-test. For values where  $p > 0.05$  the Bland-Altman plot was used to assess agreement between the two measurement methods.

Significant differences were found between CT and EOS analysis for relative vertebral rotation changes of UIV to apex (bias 4.11, 95% CI -10 to 18,  $p$  0.006) and UIV+1 to apex (bias 4.47, 95% CI -10 to 19,  $p$  0.003). However, no significant differences were found in relative vertebral rotation changes of LIV to Apex (bias 2.58, 95% CI -11 to 16,  $p$  0.06), LIV+1 to apex (bias 3.02, 95% CI -13 to 19,  $p$  0.06), UIV to LIV (bias 0.83, 95% CI -14 to 16,  $p$  0.59) and UIV+1 to LIV +1 (bias 0.48, 95% CI -9 to 10,  $p$  0.64). Bland-Altman plots showed no proportional bias. However, the variance was well beyond the acceptable clinical limits.

EOS 3D morphological analysis of vertebral rotational orientation in AIS patients showed significant differences comparing to that of CT measurements in the instrumented levels of the spine with variances that are

unacceptable. The presence of radiodensity from hardware appears to decrease the accuracy of the EOS analysis. The error seems to compound the further away one gets from the uninstrumented spine.

#### **34. TREATMENT OF THORACOLUMBAR BURST FRACTURES: EXTENDED FOLLOW-UP OF A RANDOMISED CLINICAL TRIAL COMPARING ORTHOSIS VS. NO ORTHOSIS**

**Presenter: Christopher Bailey, ON**

O. Alrehaili, ON, C. Fisher, BC, A. Fleming, ON, P. Rasoulinejad, ON, K. Gurr, ON, S. Bailey, ON, F. Siddiqi, ON, J. Urquhart, ON

We recently conducted a multicentre, prospective, randomised equivalence trial comparing orthosis (TLSO) to no orthosis (NO) in the treatment of acute AO Type A3 thoracolumbar burst fractures, and demonstrated that treatment with or without a TLSO following an otherwise similar treatment protocol is equivalent at three months post-injury. The purpose of the present study was to determine whether there is a difference in the long-term clinical and radiological outcome in patients treated with TLSO compared to NO. Here we present the clinical outcomes of five to ten year follow-up ( $7.9 \pm 1.1$  years) from a single site of the original multicentred trial.

Subjects were enrolled if they had an AO-A3 burst fracture between T11 and L3 with kyphotic deformity lower than  $35^\circ$ , no neurologic deficit, were 16 to 60 years old and were 72 hours post-injury. Between 2002 and 2009, a total of 96 subjects were enrolled in the primary trial, and randomised to two groups: TLSO or NO. The present study includes a subset of patients including 16 patients in the TLSO group and 20 patients in the NO group. The primary outcome measure was the Roland Morris Disability Questionnaire score (RMDQ) at the five to ten year follow-up. Secondary outcome measures included kyphosis, the numeric rating scale for pain, and SF36 mental and physical component summary scores at admission, two weeks, six weeks, three months, six months, and one, two and five to ten years. Treatment comparison was performed at the longest available follow-up between patients in the TLSO group and those in the NO group, and the time-weighted average treatment effect was determined using a mixed effects model of longitudinal regression for repeated measures averaged over all time periods. Missing data were assumed to be missing at random and were replaced with a set of plausible values derived using a multiple imputation procedure.

The RMDQ score at five to ten years post-injury was  $3.6 \pm 0.9$  (SD) for the TLSO group and  $4.8 \pm 1.5$  for the NO group ( $P = 0.486$ ; CI, -2.3 to 4.8). Average kyphosis was  $18.3 \pm 2.2^\circ$  for the TLSO group and  $18.6 \pm 3.8^\circ$  for the NO group ( $P = 0.934$ ; CI, -7.8 to 8.5). No differences were found between NO and TLSO groups with time-weighted average treatment effects for RMDQ 2.1 (95% CI, -0.9 to 5.0), for PCS -2.7 (95% CI, -7.9 to 2.5), for MCS -1.8 (95% CI, -6.1 to 2.6) and for average pain 0.8 (95% CI, -0.3 to 2.1).

Compared to patients treated with a TLSO, patients treated using early mobilisation without orthosis maintain similar pain relief and improvement in function for five to ten years.

#### **35. REPEAT DISCECTOMY VS. DISCECTOMY AND FUSION FOR RECURRENT LUMBAR DISC HERNIATIONS: A CSORN STUDY**

**Presenter: Christopher Bailey, ON**

A. Fleming, ON, P. Rasoulinejad, ON, J. Urquhart, ON

To determine whether repeat discectomy (DA) is superior to repeat discectomy and fusion (DF) in the treatment of recurrent lumbar disc herniation with respect to patient rated outcome at one year after surgery.

Patients undergoing a same-level DA or DF were retrospectively identified from the Canadian Spine Outcomes and Research Network (CSORN) study which is a national, prospective, database. Exclusion criteria were <18 years of age, lost to follow-up before six weeks, previous lumbar surgery, or artificial disc replacement, dynamic stabilisation or deformity correction. The primary outcome measure was leg pain measured at one year after surgery. Secondary outcome measures included back pain, Oswestry Disability Index, SF-12, satisfaction, procedure characteristics and adverse events measured pre-operatively and at 6-18 weeks, one and two years after surgery. Baseline characteristics were compared between groups. Analysis of covariance was used to

assess the difference in outcome scores between groups adjusting site, chief complaint, and baseline score. The time-weighted average treatment effect was determined using a mixed effects model of longitudinal regression for repeated measures averaged over all time periods. Missing data were assumed to be missing at random and were replaced using multiple imputation. For patient satisfaction last value carried forward was applied to missing data.

Eighteen patients had DA and forty-six had DF. The mean follow-up period was  $524 \pm 307$  days (range, 41 to 1054). The proportion of enrollees who supplied data at each follow-up visit was 100% pre-operatively, 92% at 6-18 weeks 59% at one year, and 55% at two years (14% and 34% of which had not reached the respective visit, at the time of analysis). The leg pain score at one year after surgery was  $4.4 \pm 1.3$  (SD) for the DA group and  $4.2 \pm 0.9$  for the DF group ( $P = 0.882$ ; CI, -2.8 to 2.5). No differences were found between groups with time-weighted average treatment effects for leg pain 0.1 (95% CI, -1.2 to 1.4), back pain 0.2 (95% CI, -1.2 to 1.6), ODI 1.0 (95% CI, -8.8 to 11.0), PCS 1.0 (95% CI, -3.7 to 5.7), and MCS 0.5 (95% CI, -4.4 to 5.3). Length of stay, operative time, and blood loss were significantly greater after DF than after DA ( $P < 0.001$  for all comparisons). Adverse events including dural tear (11.1% vs. 6.5%,  $P = 0.583$ ), wound infection (5.6% vs. 2.2%,  $P = 0.485$ ), and re-recurrent disc herniation (11.1% vs. 4.3%,  $P = 0.315$ ) were not different between DA and DF groups. A similar proportion of patients in DA and DF groups were extremely or somewhat satisfied at 12 months after surgery (72.2% vs. 75.6%,  $P = 0.784$ ). An equal number of patients felt that surgery met their expectations of feeling much better or better (72.2% vs. 73.3%,  $P = 0.928$ ).

Compared to patients treated with repeat discectomy, fusion patients treated with repeat discectomy alone have similar pain relief, functional recovery, and satisfaction with treatment.

### **36. METASTATIC INVOLVEMENT IN VERTEBRAL BONE MODIFIES FEATURES OF THE BONE TISSUE MATRIX IMPACTING ITS MATERIAL CHARACTERISTICS AND BEHAVIOUR**

**Presenter: Mikhail V. Burke, ON**

A. Atkins, ON, A. Golaraei, ON, V. Barzda, ON, M. Akens, ON, C. Whyne, ON

Vertebral metastases can exhibit bone-forming (osteoblastic) or bone-resorbing (osteolytic) natures or a mixture of the two. While previous studies have focused on the impact of metastatic involvement on bone microarchitecture and total mineral content, less work has been done to elucidate the impact of metastatic growth on the intrinsic features of bone tissue. The objective of this study is to further characterise the impact of metastatic-mediated modifications on bone tissue features and nanostructure on bone's material characteristics. Such research is critical for the establishment of a fundamental knowledge base needed for modelling and evaluating fracture risk and guiding future treatment options.

Osteolytic and mixed vertebral metastases were generated in athymic rats via intracardiac injection of HeLa and Ace-1 cancer cells respectively (N=17 per group). Twenty-one days post-injection, the rats were euthanised and relevant vertebrae removed for testing. Second harmonic generation (SHG) and transmission electron microscopy (TEM) imaging was used to assess collagen fibril organisation within the tissue. Backscatter electron (BSE) microscopy imaging was used to analyse mineral content and distribution within the vertebrae. Material properties (modulus and hardness) of specific ROI in the anatomy adjacent to tumour lesions were assessed utilising nanoindentation. Small defined regions around these indent points were then assessed with BSE imaging to give a focal assessment of the local mineralisation profile. To test for significant differences between groups and/or ROI, multiple-way ANOVA was performed based on a parametric mixed model.

SHG imaging showed that the susceptibility ratio (related to relative degree of in-plane vs. out-plane fibrils) increased in bone adjacent to metastatic involvement, indicative of change in fibrillar organisation compared to healthy controls. Increased occurrence of deviations in the collagen plywood motif and parallel packing structure within a lamella (degree of disorder) was observed with Ace-1 metastatic involvement, particularly within pathological osteoblastic bone growth. Both types of metastatic involvement exhibited reduced tissue mineral content. Ace-1 induced pathological osteoblastic bone, had significantly decreased tissue mineral homogeneity whereas osteolytic bone from HeLa inoculated samples saw a slight increase in homogeneity



compared to healthy controls. The modulus and hardness of pathological osteoblastic bone was diminished compared to bone in any other location of the vertebral body.

Overall observed changes in bone tissue collagen fibril organisation and mineralisation and resulting diminished material properties with metastatic involvement were most stark within pathological osteoblastic bone formation. This could explain the generally observed poor mechanical behaviour of vertebral bone with osteoblastic lesions regardless of maintained bone volume.

### **37. SHORT LINK N STIMULATES INTERVERTEBRAL DISC REPAIR IN A NOVEL LONG-TERM ORGAN CULTURE MODEL THAT INCLUDES THE BONY VERTEBRAE**

**Presenter: Michael P. Grant, QC**

N. Algarni, QC, L. Epure, QC, Q. Salem, QC, J. Antoniou, QC, F. Mwale, QC

Degenerative disc disease remains poorly understood, yet it is a disorder that is very common and can lead to a dysfunctional spine. Continued catabolism of the disc matrix, accompanied by impaired synthesis of aggrecan and collagen leads to disc degeneration. Although the intervertebral disc (IVD) has limited endogenous repair activity, induced repair may be possible by the intradiscal injection of growth factors to stimulate the production of matrix molecules. Link N (DHLSDNYTLHDRAIH) is a naturally occurring bioactive 16 amino acid peptide released by proteolysis from its parent protein, link protein. Many studies using disc cells or a rabbit model of disc degeneration have shown that it has proteoglycan and collagen anabolic effect. In a recent publication, we found that cells from the AF can release an enzyme that can cleave Link N generating a one-eight bioactive amino acid peptide termed short Link N (sLink N). Separately, we developed a novel organ culture model which possesses vertebrae and can be kept in culture alive for more than six months. The aim of this study was to evaluate the effect of sLink N on matrix restoration in this model.

Tails of 22- to 28-month-old steers were obtained from the local abattoir within four hours of slaughter and isolated using the PrimeGrowth Media kit as indicated by manufacturer (Wisent, Montreal). After isolation, the vIVDs were cultured for seven days in PrimeGrowth Culture Medium (Wisent, Montreal) with medium replaced every three days. After seven days of preconditioning in culture, degeneration was induced in IVDs by a single injection of 50 µg trypsin into the nucleus pulposus (NP). Seven days after induced-degeneration, the trypsin-treated discs were injected with sLink N (100 µg/disc, n=6 discs/group). Four of the trypsin-treated degenerate discs were injected with PBS alone to serve as a control for degeneration while four discs served as non-degeneration controls. At four weeks post treatment vIVDs were processed for biochemical analyses. Proteoglycan (predominantly aggrecan) synthesis in the NP was monitored as sulfated glycosaminoglycan using the 1,9-dimethylmethylene blue dye-binding assay, and Western blotting was performed to determine the expression of aggrecan and type II collagen in the tissue.

After four weeks of culture, the proteoglycan content measured as glycosaminoglycans (GAGs) significantly increased compared to the degeneration control when degenerate discs were treated with sLink N (Figure 1). Histological analysis revealed that the newly synthesised proteoglycan was able to restore tissue content even in areas remote from the cells. The quantity of extractable type II collagen and aggrecan was also increased when the degenerate discs were treated with sLink N.

Our results support the concept that biological repair of disc degeneration is feasible, and that the administration of sLink N has therapeutic potential in early stages of the disease.

### **38. THE EFFECT OF TUNGSTEN IN THE IVD**

**Presenter: Michael P. Grant, QC**

E. Elahie, QC, A. Bolt, QC, L. Epure, QC, A. Papanastasiou, QC, J. Antoniou, QC, K. Mann, QC, F. Mwale, QC

Tungsten has been increasing in demand for use in manufacturing and recently, medical devices, as it imparts flexibility, strength, and conductance of metal alloys. Given the surge in tungsten use, our population may be subjected to elevated exposures. For instance, embolism coils made of tungsten used in the treatment of

intracerebral aneurysms and dural fistulas have been shown to degrade in some patients. These patients presented elevated levels of tungsten, in both serum and urine, at 24 months follow-up post-surgery. In a cohort of breast cancer patients who received tungsten-based shielding for intra-operative radiotherapy, urinary tungsten levels remained over tenfold higher 20 months post-surgery. Although the toxicity of tungsten is not well described, recent reports have demonstrated carbide-cobalt nanoparticles, a tungsten-based alloy commonly used commercially in the manufacturing of industrial goods, induced cell death and genotoxicity in a human liver and renal cell line. In an *in vivo* mouse model, tungsten exposure increased tumour metastasis by altering the tumour microenvironment. In a recent report, tungsten was shown to rapidly accumulate in bone and enhance the adipogenesis of bone marrow-derived mesenchymal stem cells while inhibiting osteogenesis. Whether tungsten accumulates in other tissues and affects viability and/or function remains unknown. We recently determined that when mice are exposed to tungsten [15 ug/mL] in their drinking water, it bioaccumulates in the intervertebral disc [~3 ppm], equivalent to what is observed in bone. This study was performed to determine the toxicity of tungsten on intervertebral disc cells.

Bovine nucleus pulposus (bNP) and annulus fibrosus (bAF) cells were isolated from bovine caudal tails of 20-24 month old steers. Discs were excised and NP and AF tissues were separated. Cells were recovered by sequential digestion with Pronase followed by Collagenase, and expanded in low glucose DMEM medium supplemented with 10% heat-inactivated FBS. Cells were expanded in flasks then prepared for 3D culturing in alginate beads at a density of  $1 \times 10^6$  cells/mL. Beads were cultured in medium supplemented with increasing tungsten concentrations in the form of sodium tungstate [0, 0.5, 5, 15 ug/mL] for 12 days. A modified GAG assay was performed on the beads to determine proteoglycan content and Western blotting for type II collagen (Col II) synthesis. Cell viability was determined by counting live and dead cells in the beads following incubation with the Live/Dead Viability Assay kit (Thermo Fisher Scientific). Cell numbers in beads at the end of the incubation period was determined using Quant-iT dsDNA Assay Kit (Thermo Fisher Scientific).

Tungsten dose-dependently decreased the synthesis of proteoglycan in IVD cells, however, the effect was significant at the highest dose of 15 ug/mL. (n=3). Furthermore, although tungsten decreased the synthesis of Col II in IVD cells, it significantly increased the synthesis of Col I. Upregulation of catabolic enzymes MMP-13 and ADAMTSs were also observed in IVD cells treated with tungsten (n=3). Upon histological examination of spines from mice treated with tungsten [15 ug/mL] in their drinking water for 30 days, disc heights were diminished and Col I upregulation was observed (n=4). Cell viability was not markedly affected by tungsten in both bNP and bAF cells, but proliferation of bNP cells decreased at higher concentrations.

We provide evidence that tungsten affects matrix protein synthesis in IVD cells, possibly enhancing disc fibrosis. Tungsten toxicity may play a role in disc degeneration.

## **COA Critical Issues and Education**

### **39. COMPARISON OF THE OTTAWA SURGICAL COMPETENCY OPERATING ROOM EVALUATION (O-SCORE) TO A SINGLE-ITEM PERFORMANCE SCORE**

**Presenter: David J. Saliken, AB**

T. Wood, ON, I. Raiche, ON, W. Gofton, ON

Orthopaedic surgery programs are adopting competency-based frameworks. This requires accurate, valid assessments of both knowledge and technical performance. The Ottawa Surgical Competency Operating Room Evaluation (O-SCORE) is a nine-item surgical evaluation tool designed to assess technical competence in surgical trainees. Its validity has been shown previously and it has also been shown to be reliable. Delays in completing an operative assessment affect the clarity and detail of the results. An evaluation tool that is quick to complete could reduce the risk of delay. Further, this could result in a higher volume of resident evaluations to base progress through a residency program. Our goal was to determine if a single-item performance score completed at a separate viewing would correlate with the O-SCORE.

Nineteen residents and two staff Orthopaedic Surgeons from the University of Ottawa volunteered to participate in a two-part OSCE style station. Participants completed a written questionnaire followed by a videotaped 10-minute simulated open reduction and internal fixation of a mid-shaft radius fracture. Videos were viewed in random order and rated individually by an orthopaedic staff surgeon and two orthopaedic trauma fellows using a single-item performance score. The videos were watched again six weeks later and re-rated using the O-SCORE. Correlation between the single-item score and O-SCORE will be determined as well as further evaluation of inter-rater reliability of the O-SCORE.

The raters completed 21 ratings each. There was agreement on 60 of the 63 ratings. Kappa correlation was 0.894 ( $p < 0.0001$ ).

A single-item score correlated highly with the O-SCORE. A single-item score could potentially increase surgeon response rate due to its ease in completion. There is still benefit to a complete O-SCORE evaluations to guide specific areas of improvement and direct feedback.

#### **40. DESIGNING A SIMULATION CURRICULUM FOR ORTHOPAEDICS**

**Presenter: Marie-Eve LeBel, ON**

Simulation training can be used as an adjunct to residents' training to enhance their learning experience as it provides a unique opportunity for practicing basic to advanced techniques as well as dealing with complications. This era of competency-based training serves as grounds for our Royal College to strongly recommend the incorporation of simulation to every surgical residency program. Unfortunately, simulation is not formally integrated in an official curriculum in most of our current Canadian orthopaedic residency training programs. There are also no formal guidelines from the Royal College about ways to design and implement such curriculum. This paper reports the steps our program followed to design an Orthopaedic Simulation Curriculum.

A review of the medical education literature was done and an Orthopaedic Simulation Curriculum was designed following the Six-Step Approach recommended by Kern (Kern, 2009). Kern's systematic framework includes 1) problem identification and general needs assessment, 2) targeted needs assessment, 3) formulation of goals and objectives, 4) selection of educational strategies, 5) implementation, and 6) program evaluation and feedback.

All residents of Western's orthopaedic program were surveyed for the needs assessment. Based on the residents' feedback, the curriculum was designed and tailored for their specific needs per clinical teaching unit (CTU). In order to distribute the teaching and assessment load across our city, each CTU was assigned part of this program for future implementation. The new curriculum is currently under review by each CTU head. Therefore, implementation of this curriculum and following iterative curriculum evaluation are planned for the near future.

An Orthopaedic Simulation Curriculum was designed and proposed to our program using Kern's approach to curriculum design. Implementation of this curriculum is pending. This type of curriculum can be designed and specifically tailored for any surgical program following this Six-Step Approach.

#### **41. DESIGNING AND PILOTING INTRA-OPERATIVE VIDEOS FOR ORTHOPAEDIC SURGICAL TRAINING**

**Presenter: Colm McCarthy, ON**

A. McGuire, ON, P. Kalun, ON, J. Wilcox, ON, A. Akai, ON, N. Wagner, ON, B. Petrisor, ON, R. Sonnadara, ON

Surgical education has changed dramatically over the last several years with increased regulation of resident duty hours and call hour reform. Given fewer clinical learning opportunities and an exponentially expanding knowledge base, learners are now pursuing online learning to supplement their clinical exposure and indeed, online resources are becoming integral to surgical training. Video-based instruction provides a means of increasing resident exposure to cases while not infringing upon duty hour restrictions, and new technology makes it easy for such videos to be accessed securely from anywhere. Little research exists on what makes an effective video for learners and how such videos are best created. This study serves as a guide to inform educators about what

some residents and instructors have found useful in intra-operative surgical training videos and offers suggestions for creating videos that we have found to be effective.

Several orthopaedic procedures were filmed and the footage used to create educational surgical videos with all patient identifiers removed. A video of an open reduction internal fixation of an ankle fracture was shown to three junior residents, three senior residents, and three staff physicians. Semi-structured interviews were conducted with each resident and staff physician to explore perceptions of what constitutes a “helpful” training video. Interviews were audio recorded and transcribed verbatim. Interviews were then coded by two researchers and analysed using thematic analysis and member check.

Three themes (Learning, Access, Video) and nine subthemes (Use, Application, Platform, Hours, Timing of Use, Content, Length, Narration, Filming Quality) were identified. Residents at all levels of training and staff agreed that video-based instruction will play a critical role in the advancement of resident education. They also suggested that in order to be educationally meaningful, videos must be of high narrative and visual quality, short, easily accessible 24 hours a day on phones, tablets, and computers, and well organised.

Well-designed videos are in high demand by both learners and instructors. Both groups feel that in the context of duty hour restrictions video-based instruction will play a crucial role in the future of surgical education. While video-based instruction will never replace direct clinical learning, it serves as a valuable tool to increase resident exposure to cases and procedures, and allows them to maximise their knowledge and preparedness prior to the start of a case. The success of video-based education begins with the quality of filming. While it can be challenging to produce high quality videos, this study provides educators with recommendations based off the success we have had and tips and tricks to ease this process.

## **42. LEARNING NEW SKILLS IN PRACTICE: HOW SURGEONS MAKE A RISK ASSESSMENT AND KNOW WHEN AND HOW TO IMPLEMENT NEW PROCEDURES**

**Presenter: Ashkay Seth, ON**

C. Moulton, ON, T. Wood, ON, W. Gofton, ON

Surgeons regularly make changes in their practice to ensure they are providing high quality patient care. This includes the process of learning and safely integrating new skills, techniques and technologies into practice. Despite evidence that introducing a new surgical technique is associated with a learning curve during which there are reduced surgical and patient outcomes, there are no suggested protocols in place to support a surgeon in safely introducing a new procedure into an established practice. When faced with the challenge of integrating a new surgical procedure into practice, surgeons must determine when they are ready to overcome the associated risks. This study sought to understand how surgeons experience risk when learning and integrating a new procedure into practice.

This study took place at two large Canadian academic medical institutions from 2016 to 2017. The authors recruited a purposive sample of surgeons who had recently learned and integrated a new surgical skill, technique or technology into their practice. Using a modified constructivist, grounded theory approach, semi-structured interviews were conducted, transcribed, anonymised and combined with memos. The interviews explored surgeons’ experiences learning and implementing new procedures into their practice. The interview transcripts were analysed using constant comparative analysis, emergent themes were identified and a conceptual framework was developed for understanding how surgeons experience the risk associated with learning and integrating a new procedure into practice. Post-hoc member checking was performed to ensure resonance of the findings.

Twenty surgeons participated, with equal participation from both institutions. Surgeons described their approach to learning and implementing new skills as a process that included identifying a clinical problem, developing technical skills, implementing those skills in practice, evaluating the results and refining technique. Throughout this process, participants’ experience of risk was influenced by both individual, personality driven factors and factors impressed upon them by their departmental, institutional, professional and societal environments.

A framework for understanding how surgeons experience risk when learning and implementing new skills was developed. The multifactorial interplay between a surgeon's individual perception of risk and the cultural influences that serve to facilitate or hinder the implementation of a new surgical skill is at the core of this experience. An increased awareness of these factors can foster the development of guidelines for supporting surgeons looking to learn and implement new skills, techniques and technologies while maximising patient safety.

#### **43. SPECIFICITY OF 30 AND 90-DAY READMISSION AFTER PRIMARY JOINT ARTHROPLASTY USING AN INSTITUTIONAL AUTOMATED SYSTEM**

**Presenter: Brian P. Chen, ON**

J. Dobransky, ON, S. Poitras, ON, A. Foster, ON, P.E. Beaulé, ON

In an effort to curb the rapidly growing cost of healthcare, government agencies and policymakers established programs to evaluate quality of care and use it to influence hospital funding. Readmission rate has emerged as an important metric to measure quality. A concern surrounding this metric is that the use of all-cause readmission may overestimate readmission due to complications unrelated to surgery. The aim of this study was to compare the specificity of 30 vs. 90-day timeframe in identifying readmission due to surgery-related events after primary total hip and knee arthroplasty.

At our academic tertiary care hospital, an institutional adverse events reporting system was established to report readmission within 90-days of discharge. This database was queried for patients who underwent primary total hip or knee arthroplasty between January 1, 2013 and December 31, 2015. The electronic medical records of readmitted patients were reviewed to determine whether a surgery-related complication was most responsible for the readmission. Surgery-related events included issues arising from the joint or incision (e.g. dislocation or infection), periprosthetic fracture, venous thromboembolic (VTE) events, and events that are likely attributable to new post-operative medications (e.g. bleeding in the context of DVT prophylactic medication). Analyses were performed on the entire queried patient list (90-day readmission) and separately with only patients readmitted within 30-days of discharge. Proportion of readmission due to surgery-unrelated causes was compared using chi-squared test.

During the study period, 2,952 patients underwent primary total hip or knee arthroplasty, 67 (2%) and 122 (4%) of which were readmitted to hospital within 30 and 90 days of discharge, respectively. Using a 30-day timeframe, 17 of 67 (25%) of readmission were not due to surgery-related complications. In comparison, 40 of 122 (33%) of readmission were not due to surgery-related complications when using a 90-day timeframe ( $p = 0.054$ ). Causes for readmission unrelated to surgery were mostly decompensation or exacerbation of pre-existing comorbidities. Notably, two uncomplicated patients were readmitted for replacement of the contralateral joint. Surgery-related causes included periprosthetic fracture, hematoma, infection (surgical site or joint), wound dehiscence, hip dislocation, quadriceps tendon rupture, and VTE.

Both 30 and 90-day timeframes captured a large proportion of readmission due to causes unrelated to surgery. There was a trend towards lower proportion of readmission due to surgery-unrelated causes using the 30-day timeframe. The use of all-cause readmission may unfairly overestimate readmission rates, especially for services that treat patients with multiple comorbidities. This has significant funding implications in an era where readmission rate is an important metric influencing hospital funding.

#### **44. "CAN YOU FEEL IT?": AN EARLY EXPERIENCE WITH SIMULATED VIBRATION TO RECREATE GLENOID REAMING**

**Presetenter: Jason Strelzow, Scotland**

J. Kusins, ON, L. Ferreira, ON, M. Lebel, ON

Surgical simulators gained attention as teaching tools to facilitate mastery of complex psychomotor skills, while maximising patient safety/learner experience. Haptic devices generate kinesthetic simulated tactile feedback to represent real world tactile experience. Studies demonstrated the importance of meaningful haptic feedback in

simulators' development. Although force, torque and dampening are common haptic outputs, vibration feedback has not routinely been utilised in surgical simulations. Additionally, no current shoulder arthroplasty surgical simulator models exist. The present study focuses on vibration haptics of glenoid reaming in shoulder arthroplasty using a novel glenoid reaming haptic simulator.

Face and content validation were evaluated for a recently developed custom haptic simulator. The simulator was constructed using a vibration transducer, transmitting simulated reaming vibrations through a 3D printed glenoid utilising a custom fitted 3D printed non-wearing tip mounted to a powered reamer. Previous unpublished testing established feasibility and proof of concept for the simulator. Nine fellowship-trained shoulder surgeons performed the system's validation. Face validity was completed through a questionnaire. Content validation and system fidelity were evaluated with experts performing standardised simulated reamings. The first included twenty samples of randomly selected surface "profiles" (cartilage/subchondral/cancellous): experts were asked to describe the "profile" based on vibration feedback alone. Secondly, experts reamed ten simulated glenoid samples and had to identify the cartilage/subchondral interface based solely on vibration feedback.

The overall face validity score for the system was 4.09/5. Experts gave the highest scores to "ease of tool manipulation" (4.19/5) and "realism of simulator's reamer-glenoid interface" (4.11/5). The perceived simulator's utility as a teaching tool was also highly ranked (4/5). A mean global system assessment score of 6.8/10 (range 5-10) was recorded. Overall 52 ±2% of the surface profiles were identified correctly and 69 ± 0% of the cartilage layers. System fidelity was high based on 77 ± 2% of experts identifying the transition from simulated cartilage to subchondral bone. The interclass correlation coefficient (ICC) for experts reaming to the subchondral plate was 0.68 (CI 0.26 - 0.91).

This study is the first to examine a simulated glenoid reamer and feasibility of haptic vibrational feedback for training. Experts validated haptic vibration for glenoid simulation and the results suggest this tool may be a useful training adjuvant. The use of a functional reamer provided additional realism. The use of 3D printed simulated glenoids and reamer tips provide a cost-effective method to simulate patient-specific cases from CT scans. We believe this study will facilitate the development of a comprehensive and realistic shoulder arthroplasty simulator for all orthopaedic trainees.

#### **45. INFORMAL REGIONALISATION OF UNCOMPLICATED PAEDIATRIC FRACTURE CARE IN THE GREATER TORONTO AREA**

**Presenter: Daniel Pincus, ON**

S. Morrison, ON, M. Gargan, ON, M. Camp, ON

Supracondylar humerus (SCH) and femur fractures are the two most common operatively treated paediatric fractures in Ontario. Operative management of simple and complex paediatric fractures is an expected competency within the Objectives of Training in the specialty of Orthopaedic Surgery for the Royal College of Physicians and Surgeons of Canada (RCPSC). However, paediatric academic health science centres may be providing care for increasing numbers of uncomplicated fracture patients previously treated in the community.

The primary objective of this study was to examine trends for uncomplicated paediatric fractures presenting to a specialised paediatric centre from anywhere in the Greater Toronto Area (GTA, population 6.054 million in 2011). Consecutive patients admitted to The Hospital for Sick Children (SickKids) and requiring operative intervention for a SCH or femur fracture between April 1, 2008 and March 31, 2015 were eligible for inclusion. Patients over age 14, "complicated" cases necessitating paediatric orthopaedic specialist referral, and those living outside the GTA were excluded. Changes in operative incidence rates were calculated using incidence rate ratios (IRRs) for one-year increments spanning each fiscal year. IRRs were calculated by multivariable negative binomial regression models to address potential temporal confounding by demographic, injury and admission characteristics.

Baseline characteristics of 945 SCH fractures and 421 femur fractures included in the study population were similar irrespective of which year fixation occurred. The annual incidence rate of uncomplicated SCH fracture cases increased from 108 to 169 (or by 53%) at an adjusted rate of 7.5% per year (adjusted IRR = 1.075,

95% CI = 1.072-1.079,  $p < 0.001$ ). Similarly, the annual incidence rate of uncomplicated femur fracture cases increased from 49 to 69 (or by 45%) at an adjusted rate of 5.3% per year (adjusted IRR = 1.053, 95% CI = 1.044-1.062,  $p < 0.001$ ). Significant increases in adjusted fracture rates were observed independent of fracture classification, fracture stabilisation method, whether patients were transferred from an outside hospital or presented directly, patient geographic location, or the season in which the fracture occurred.

Adjusted annual incidence rates to our paediatric academic health science centre significantly increased between 2008 and 2014. We advocate that policy and funding regarding paediatric orthopaedic trauma care in our jurisdiction be formalised. Further work is required to assess both the clinical impact of informally-regionalised care, and to understand why the phenomenon is occurring.

#### **46. A PROCESS FOR CENTRALISING ASSESSMENTS IN COMPETENCY BASED EDUCATION**

**Presenter: Polinka Mironova, ON**

O. Safir, ON, D. Burns, ON, J. Wolfstadt, ON, W. Kraemer, ON, M. Nousiainen, ON, J. Hall, ON, P. Ferguson, ON, G. Sisodia, ON, J. Williams, ON, CBC Ortho Group, ON, Veronica Wadey, ON

The University of Toronto, Division of Orthopaedic Surgery uses its seven years of competency based curriculum (CBC) residency program to assess the process of centralising assessments. Working with the assessments from the boot camp module, we aim to explore how evaluations across modules can be used in competency based education.

A subcommittee reviewed and analysed the assessment methods used in the bootcamp module. assessment tools for conceptual understanding and technical skills were cross-referenced with the module's curriculum map to ensure that all components of educational requirements were reflected in the evaluation process and predictive of competent performance. A validated multiple choice questionnaire (MCQ) and evaluations of procedures (EOPs) including a global rating scale (GSR) were the tools used. Evaluations were amended and externally reviewed for accuracy prior to being used for the boot camp evaluation. Eleven residents participated in two weeks of preparation camp and two weeks of the traditional orthopaedic boot camp module, deemed essential for beginning resident education. An end of module exam was given to all residents, and data from the MCQ and EOP components of the evaluation were recorded. Descriptive and quantitative analyses were completed to assess performance with immediate feedback delivered to the residents. Resident feedback pertaining to their experience during the module was obtained.

The MCQ scores were uniformly high for 11 residents; the average was a normalised 90%. Graded scores for the six EOPs varied across the six procedures and the 11 residents. The mean GRS for the 11 residents across the EOPs was 24, but the GRS for individual residents ranged from 16 to 30. The high MCQ scores for the residents were not correlated with the mean GRS scores. Residents were well-versed in the cognitive domain but functioning at more of a novice level with respect to technical skills. Residents were very satisfied with the content, teaching and overall experience during boot camp and perceived they were better prepared to begin their orthopaedic residency.

A process to develop and deliver a centralised evaluation for residents completing a module in a competency based education system may require: 1) careful and module specific reviews of written and clinical skills templates to ensure correlation with the module's curriculum map; 2) organisation of the evaluation infrastructure including, residents to take the evaluation educated evaluators and exam venue at a suitable time for all within the program; 3) a complete analyses of the performance of residents including feedback and reflection on the process and; 4) a mechanism by which resident performance can be predicted and correlated for future modules.

#### **47. LOST WAGES SECONDARY TO ANKLE ARTHRITIS IN BRITISH COLUMBIA IN PATIENTS UNDERGOING ANKLE FUSION OR REPLACEMENT**

**Presenter: Alastair Younger, BC**

O. Gagner, BC, A. Veljkovic, BC, M. Penner, BC, K. Wing, BC

Waiting times for ankle arthritis surgery are often over three years. While waiting patients may become unemployed and lose income. The purpose of this paper is to calculate the lost wages annually and over the remaining work lifetime of a cohort of patients, and use this to extrapolate the lost wages for patients undergoing ankle arthritis surgery in the Province of British Columbia.

A series of patients undergoing surgery for end stage ankle arthritis at a single Canadian teaching hospital were prospectively enrolled. Patients under the age of 60 were studied. This retrospective study used the report of employment at the time of surgery, at two-years follow-up and at longer term (average 6.7 years) follow-up. The patients were enrolled from 2002 to 2013 and had minimum two years follow-up. Employment status was reported using the MODEMS outcome instrument, patients being asked if they were (1) working, (2) on leave of absence, (3) unemployed, (4) homemaker, (5) a student, (6) retired (not due to ill health), (7) disabled or retired due to ill health. Items two, three and seven were considered unemployed. The lost income for unemployed patients was determined using the statistics Canada website (<http://www12.statcan.gc.ca/nhs-enm/2011>), stratifying for age and sex using the Province of BC figures from 2011. The lost wages from the year of surgery until 75 years of age were calculated.

Of 276 patients, 127 patients were under the age of 60 at the time of surgery. The average age was 51 years old. Of these, 57 (45%) were working at the time of surgery, nine (7%) did not specify their work status, and 61 were unemployed (48%). The lost wages in the year before surgery for the unemployed cohort was \$2.58 million. Two years after surgery the employment rate improved by 6% (eight patients). However 53 patients were still unemployed for lost wages of \$2.37 million. At longer term follow-up there were 50 working, 12 not specified, and 65 not working. The lost wages were \$2.55 million dollars. Because few patients became employed during follow-up we assume that they will never be employed again. The total lifetime loss of wages for this group was therefore \$51.81 million. There were 140 ankle arthritis operations performed in 2013 in BC, and 64 (46%) patients were likely aged under 60. Twenty-nine (48%) are likely unemployed. The lost wages per year for the working lifetime of these patients by extrapolation is \$22.8 million. Using prior statistics (Younger et al, FAI 2015) the cost of ankle arthritis surgery in BC is around \$1.1 million.

Earlier access to care may maintain the employment status in this patient group. The cost of surgery is justified based on the lost income. It would seem that once these patients are out of the work force they cannot re-enter because they are “damaged goods” in the employment market. Preventing these patients from becoming unemployed by earlier access makes financial sense and is compassionate care.

#### **48. CHANGES IN HEALTH STATE IN PATIENTS AWAITING ORTHOPAEDIC FOOT & ANKLE CARE: A PROSPECTIVE HUMAN BEHAVIORAL STUDY**

**Presenter: Lauren E. Roberts, BC**

K. Wing, BC, M. Penner, BC, A. Veljkovic, BC, J. Sutherland, BC, J. Nacht, BC

Prolonged wait times for non-urgent, scheduled orthopaedic foot and ankle care are a major barrier to patient care in Canada's solely public healthcare system. The physical and emotional effects of such wait times on the patient's overall health and wellbeing can be significant as previously established in the major joint arthroplasty wait time literature. To our knowledge, this effect has not previously been quantified in patients waiting for non-emergent foot and ankle orthopaedic care. The current study looks at effect of wait times on patients' health status and quality of life as they await Orthopaedic foot and ankle care.

A prospective longitudinal survey design was implemented to assess the health status of local patients awaiting orthopaedic foot and ankle assessment in our local health region. Our local foot and ankle group has established a foot and ankle screening triage clinic (FAST) in which a non-surgical Orthopaedic specialist triages all new referrals received from general practitioners. Those who require strictly non-operative management were not referred on to a surgeon but rather completed their treatment strictly through the FAST clinic. All patients referred to the FAST clinic were considered. Each patient received a set of questionnaires at time of referral. Study participants were surveyed using validated generic instruments to assess pain (PEG-3), anxiety and



depression (PHQ-9). Questionnaires were repeated at each point of contact moving forward culminating at six months following completion of non-surgical or surgical treatment.

As of September 2014, 1,400 patients had received a mail out of the questionnaire at the time of being referred to the FAST clinic by their general practitioner. As of September 2015, 514 patients (36%) responded and five patients withdrew. Of these 514 patients, 111 (21%) had their initial FAST visit whereas, 403 (79%) were still presently awaiting their initial visit. As of September 2015, 221 patients completed initial questionnaires regarding pain (PEG-3) and depression (PHQ-9) at all time points. The total wait to be seen in the triage clinic was 208 days. Those who went through the clinic and on to surgical consult had a total wait time of 251 days. Those treated entirely in the FAST clinic (59%) had significantly lower pain ( $p=0.034$ ) and depression ( $p<0.0001$ ) scores. Those requiring ongoing management by a surgeon had no significant improvement in pain ( $p=0.5886$ ) or depression ( $p=0.1408$ ).

Alternate triage models such as the FAST clinic highlighted here are an important means of mitigating wait times and offloading the demand on Canadian surgeons. Our results show that the majority of new referrals from general practitioners can be managed in this non-surgical clinic and do not require surgical opinion. Interestingly, these patients were also found to have significant improvements in pain and depression scores following this particular care pathway compared to their baseline measures.

#### **49. THE UTILITY AND COST-EFFECTIVENESS OF USING HIGH-FIDELITY, SOFT-EMBALMED SPECIMENS FOR TEACHING AND ASSESSMENT OF ORTHOPAEDIC SURGICAL PROCEDURES**

**Presenter: Michelle L. Zec, ON**

G. Venne, QC, R. Eveleigh, ON, R. Ellis, ON, D. Pichora ON

Surgical educators are tasked not only with conveying the knowledge base of their specialty, but also a technical skill set, and the necessary anatomical knowledge to support that skill set. Competency-based surgical curricula therefore require appropriate models for both teaching and assessing these attributes. In this study, we wanted to assess the utility of using (and re-using) soft-embalmed specimens when performing procedures of the hand and wrist. We also wanted to explore the cost-effectiveness of such an approach.

In Phase 1, our aim was to evaluate the utility of using soft-embalmed (SE) specimens vs. fresh frozen thawed (FFT) specimens for teaching procedures of the hand and wrist. Thirteen orthopaedic residents (PGY 1-5) participated in this study. Residents used both FFT and SE specimens to practice surgical exposures as well as reconstructive techniques. Upon completion of this lab, residents were asked to evaluate both types of specimen. In Phase 2, SE specimens were used by residents on three different occasions over a period of four months. Residents serially evaluated the specimens for suitability for ongoing use.

Phase 1: For soft tissue dissection, residents preferred using the SE specimens over the FFT ones by a 10:3 margin ( $p=0.007$ ). For reconstructive procedures, there was no significant difference in resident preference and 30% of residents perceived the specimens to be comparable. Phase 2: For the first task, 15 residents performed an open carpal tunnel release (CTR), with 66% stating that performing a CTR on an SE specimen was 'very realistic' to 'extremely realistic'. Eighty percent stated that a simulated CTR was a 'very useful' to 'extremely useful' measure of their performance. For the second task, eight residents re-used specimens from the previous session (two months earlier) to perform an LRTI and an ulnar shortening osteotomy. After this session, 83% of the residents agreed with the statement: "It was easy to develop soft tissue planes with this model". Residents disagreed (66%) or strongly disagreed (33%) with the statement: "the specimen showed signs of degradation or decay". At the final session, six residents performed diagnostic elbow scopes as well as exposures about the elbow. After this session, 88% of residents reported that the SE specimens were useful for learning approaches to the elbow and 66% felt they were helpful for learning arthroscopy. Eight out of nine residents felt there had not been significant deterioration in soft-tissue properties. Comparing the cost of the specimens utilised in Phase 2, the embalmed specimens cost \$624 per specimen vs. \$522 for FFT. However, when specimens were re-used 3x, the cost per specimen dropped to \$208.

SE specimens provide a high fidelity model that residents rate as comparable or superior to FFT specimens. SE specimens may be reused over a long time period. SE specimens are very cost-effective when re-used on multiple occasions.

## **50 – DEVELOPMENT AND IMPLEMENTATION OF A PHYSICIAN ASSISTANT SHOULDER EXPERT ROLE WITHIN A MULTI-PROVIDER REGIONAL HUB**

**Presenter: Farah Nabi, ON**

S. Galloway, ON, J. Lobo, ON, J. Shantz, ON

The Shoulder Centre TSC at Rouge Valley Health System (Ajax) is the hub of a multi-provider regional collaborative, including orthopaedic surgeons, non-surgeon specialists, primary care providers (PCP), physician assistants (PA), and physiotherapists. After much research, TSC's clinical team chose the PA as the hubs' preferred allied health provider as there is strong support in the literature for their ability to enhance both quality outcomes and patient satisfaction within a multi-provider team. Orthopaedic surgeons may delegate a range of responsibilities to PAs, including performing histories and physicals, ordering and interpreting diagnostic tests, prescribing medications and therapeutic interventions.

The purpose of this study was to develop and implement a 'made in Ontario' shoulder specialized PA role and to demonstrate its capacity to increase patient accessibility to quality specialised shoulder care with improved patient satisfaction and decreased system costs (MRI utilisation and specialist visits).

Key performance metrics to be reported include: Implementation of the PA Medical Directives; Implementation of the Shoulder Specialised PA training program; Average T1 or 'time-to-accurate diagnosis' by the PA (right provider); % Pairing of the right patient to the right provider (i.e. % of Type C assessments by the PA); Reduced cost per consult by the shoulder specialised PA; High PA patient satisfaction scores; Reduced proportion of orthopedic surgeon consults.

TSC team completed / implemented the shoulder specialised PA medical directives. TSC team completed the design / implementation of the shoulder specialised PA training program. TSC completed a Q1/Q2 results report dashboard comprising of the following performance metrics: The average time-to-consult T1 for the PA (Triage Type C) was seven weeks vs. a target of six weeks; The PA saw 33% of all provider consults (100% were triaged as Type C vs. a target of 80%); The cost per consult and follow-up (\$) for the PA was 29% and 50% respectively of that of the orthopaedic surgeon; PA patient satisfaction scores were similar to those of the surgeon; In Q1/2 the PA saw 434 consults and 157 follow-ups in a total of 270 hours of work (or 34 days). This represents 0.28 FTE. Given the yearly salary of the PA is \$100,000, the total cost for the clinical visits during Q1/2 for the PA was \$14,000. The cost of the same work if billed by an orthopaedic surgeon would have been \$40,000. This represents a six month savings of \$26,000. At a 1.0 FTE, using the same proportion of consults/follow-ups, estimated net savings would be \$185,000/year for 3000 consults and 1100 follow-ups.

The shoulder specialised PA makes for an efficient, high quality and cost effective first tier allied provider within a multi-provider specialty team. This role enables improved patient access and satisfaction and the development of a fiscally sustainable model of specialty care. The cost of the PA should be best considered for inclusion within a future alternative funding model (bundled - shared savings models).

## **51. MINIMISING OPIOID EXPOSURE IN ORTHOPAEDIC SURGERY; A PROSPECTIVE, RANDOMISED CONTROLLED TRIAL**

**Presenter; Supriya Singh, ON**

C. Clarke, ON, A. Lawendy, ON, D. Sanders, ON, M. Macleod, ON

Prescription narcotic abuse and overdose is a rampant issue with long-term consequences on our patients and society. Prescription opioid related death rates in London, Ontario (8.8/100 000) are more than double the average provincial rate. Orthopaedic surgeons are known to be the third highest opioid prescribers amongst all physicians. The purpose of this prospective, randomised controlled trial was to evaluate the role of a post-

operative pain guideline pamphlet on patient's pain satisfaction, on number of patients seeking a renewal prescription and on disposal of leftover prescription medication.

This study included patients' aged 18-65 undergoing elective foot and ankle surgery at London Health Sciences Centre, who are opioid naïve and have no pre-existing chronic pain conditions. Exclusion criteria were chronic pain syndromes, chronic kidney disease, patients with allergies to our standardised protocol medications or patients with previous opioid abuse. Patients consenting to participate were divided into low, medium and high use groups according to anticipated post-operative prescription narcotic usage. Examples of each group: low (hardware removal), medium (first MTP surgery) and high (triple ankle arthrodesis). Patients in each group were randomised to either receive written discharge instructions for management of their post-operative pain or no written instructions. The control group received no pamphlet, whereas the intervention group received a pamphlet outlining post-operative pain expectations and recommendations for opioid medication usage and disposal. Both groups received equivalent prescriptions targeted to the use group. At the four week post-operative mark, a telephone interview was conducted to evaluate the primary outcome of pain satisfaction using the modified brief pain inventory. Secondary outcomes included renewal of opioid prescription and disposal method of leftover medication. Statistical analysis was done using two sample t-test .

An interim analysis of 40 patients (low use: 10, medium use: 18, and high use: 12) was done. Out of the 40 patients, 19 received post-operative pain instructions and 21 did not. On average, pain satisfaction post-operatively was 8.5 +/- 1.4 out of 10, where 10/10 represents completely satisfied. Interference scores averaged 19.4 +/- 13.7 out of 70. Interestingly, not one patient used the entirety of their prescription thus zero patients required a renewal of their prescription. Only 2/40 patients returned their surplus medication to the pharmacy and neither patient had received instructions to do so.

Written instructions may influence post-operative pain satisfaction and opioid use. Orthopaedic patients commonly have leftover prescription medication which they do not dispose of. Overprescribing narcotic medication may contribute to the issue of opioid abuse. As Orthopaedic Surgeons, we should consider our role in minimising opioid prescriptions post-operatively.

## **52. DELAYED ENDOTHELIAL PROGENITOR CELL THERAPY PROMOTES BONE DEFECT REPAIR IN A PRE-CLINICAL RAT MODEL**

**Presenter: Brent D. Bates, ON**

C. Godbout, ON, D. Ramnarain, ON, E. Schemitsch, ON, A. Nauth, ON

Large bone defects commonly occur following open bone fractures, and despite the gold standard grafting treatment by orthopaedic surgeons, these defects often fail to heal, resulting in nonunion. Recent experimentation in animal models has suggested that endothelial progenitor cells (EPCs) are capable of enhancing bone defect repair when applied acutely to surgically created defects. However, acute cell therapy may not completely replicate the situation that occurs clinically because osseous reconstruction is typically delayed following trauma due to increased infection rates associated with immediate treatment. Therefore, the purpose of this study was to investigate the use of EPCs in a more rigorous, clinically relevant model of chronic bone defects, and to compare delayed delivery of EPCs to EPCs delivered in acute fashion.

Five-millimetre segmental defects were surgically created in the right femora of male Fischer 344 rats. The defects were stabilised with mini-plate and screws, and left empty for three weeks. EPCs were isolated from the bone marrow of Fischer 344 rats, and subsequently expanded in culture for seven to eight days. After three week delay, rats were randomised to either open surgical delivery of one million EPCs on a Gelfoam scaffold, or Gelfoam scaffold alone. A second group of rats underwent the same femur fracture surgery, and were immediately treated with either one million EPCs on Gelfoam, or Gelfoam alone. Plain serial radiographs were taken at two week intervals, and animals were sacrificed at 10 weeks post-intervention. Defect repair was then analysed by microCT analysis and biomechanical testing. Two-way ANOVA with multiple comparisons was utilised to test for differences between the groups.

All animals treated with EPCs had complete defect union at 10 weeks post-treatment, whereas animals treated with Gelfoam control had complete bridging in only 37.5% of animals. Upon microCT analysis, delayed treatment with EPCs did not significantly increase bone volume fraction compared to control ( $p=0.115$ ); however, trabecular number and trabecular spacing were significantly improved in the EPC group ( $p=0.005$  and  $p=0.007$ , respectively). Additionally, ultimate torque and torsional stiffness were both significantly increased when defects were treated with EPCs compared to control ( $p=0.022$  and  $p=0.003$ , respectively). No radiographic, morphometric or biomechanical differences were observed between acute and delayed treatment with EPCs.

Results from this study indicate that treatment with EPCs promotes increased union rates and greater recovery of biomechanical function compared to a control group, and that this response does not differ between acute or delayed treatment. These data suggest that open surgical delivery of EPCs on a collagen carrier may be effective for the treatment of non-healing bone defects in a clinical scenario, as well as for the acute treatment of bone defects following planned tumour resection.

### **53. BIOMECHANICAL EVALUATION OF THE SCAPHOLUNATE LIGAMENT AND SECONDARY STABILISERS ON SCAPHOID AND LUNATE KINEMATICS**

**Presenter: Hakim Louati, ON**

K. Culliton, ON, H. Uthoff, ON, G. Cron, ON, G. Melkus, ON, A. Sheikh, ON, O. Laneuville, ON, P. Lapner, ON, G. Trudel, ON

The scapholunate ligament (SLL) is a commonly injured intercarpal ligament, and is considered the primary stabiliser of the SL joint, but a complex configuration of secondary stabilisers including the scaphotrapezium-trapezoid ligament (STTL) and radioscaphocapitate ligament (RSCL) may also contribute to SL kinematics. The anatomy of the SLL and other wrist ligaments have been established, yet the functional role of each ligament in controlling carpal motion remains unclear. This *in vitro* study quantified scaphoid and lunate kinematics during wrist flexion-extension following sequential sectioning of the SLL and secondary stabilisers.

Cadaveric upper limb specimens ( $n=8$ ,  $74\pm 11$  yrs) were amputated mid-humerus. To quantify carpal motion, optical trackers were attached to the scaphoid and lunate under fluoroscopic control, as well as the third metacarpal and radius. The wrist flexors/extensor tendons were exposed and sutured at their musculotendinous junction. Specimens were mounted on a wrist motion simulator in neutral rotation with the elbow at  $90^\circ$  flexion. Muscle tone loads were produced using servomotors connected *via* cables to each muscle group. Five cyclic motion trials of wrist flexion-extension were performed at  $5\text{mm/sec}$  for each stage (S1: intact wrist, S2: dorsal SLL cut, S3: complete SLL cut, S4: SLL & STTL cut, S5: SLL, STTL, & RSCL cut). Data was analysed from  $\pm 45^\circ$  wrist flexion-extension, reported in  $5^\circ$  increments.

In flexion, there was a significant increase in scaphoid flexion ( $p=0.01$ ) and lunate extension ( $p=0.01$ ) following ligament sectioning. Each consecutive sectioning stage significantly increased scaphoid flexion compared to the intact wrist (S2  $1.5\pm 1.5^\circ$ ,  $p=0.02$ ; S3  $4.4\pm 3.3^\circ$ ,  $p=0.007$ ; S4  $4.5\pm 3.8^\circ$ ,  $p=0.01$ ; S5  $4.6\pm 3.7^\circ$ ,  $p=0.01$ ). There were significant increases in lunate extension for S3-S5 when compared to the intact wrist (S3  $3.5\pm 3.6^\circ$ ,  $p=0.03$ ; S4  $3.9\pm 3.8^\circ$ ,  $p=0.03$ ; S5  $4.8\pm 4.6^\circ$ ;  $p=0.02$ ). In extension, there were no significant changes in scaphoid motion ( $p=0.7$ ) but there was a significant increase in lunate extension after ligament sectioning ( $p=0.03$ ). S4 and S5 caused a significant increase in lunate extension when compared to the intact wrist (S4  $3.5\pm 4.1^\circ$ ,  $p=0.05$ ; S5  $4.3\pm 4.2^\circ$ ,  $p=0.02$ ).

SLL sectioning caused significant changes in scaphoid and lunate kinematics, while subsequent STTL and RSCL sectioning induced small but significant changes. Following sectioning of the SLL, STTL and RSCL the scaphoid flexed more during wrist flexion and the lunate extended more throughout wrist flexion and extension. While the magnitude of these changes were relatively small compared to the changes observed in patients with SLL injuries, this suggests that other ligaments may be disrupted or become gradually attenuated over time clinically. A better understanding of the functional role of the primary and secondary ligamentous structures at the SL joint may assist in the development of more effective treatment strategies following SLL injury.

## **54 - THE EFFECT OF DISTAL RADIUS DORSAL ANGULATION ON CAPITOLUNATE CONTACT MECHANICS**

**Presenter: Clare E. Padmore, ON**

H. Stoesser, ON, G.D.G. Langohr, ON, E. Lalone, ON, J. Johnson, ON, G. King, ON

Distal radius fractures are the most frequent fractures experienced by patients. Healing with some degree of dorsal angulation (DA) is extremely common when treated with closed reduction and casting. This may result in reduced wrist motion, weakness and/or pain. Current literature suggests that distal radius DA deformities can alter capitulum alignment, as an adaptive dorsal intercalated segment instability. However, the changes in articular capitulum contact, resulting from DA deformities has yet to be quantified. The purpose of this study was to quantify the effect of distal radius DA deformities on the contact mechanics of the capitulum joint, and compare these results to the native state.

Four cadaveric forearms (mean age  $78 \pm 9$  yrs) were mounted to a custom passive wrist motion simulator, and subjected to flexion-extension motion trials. The 3D position and orientation of the distal radius, lunate, and capitate were measured using an optical tracking system. A distal radius implant was used to simulate distal radius DA deformities (10, 20, and 30 degs), in addition to the native state. Coordinate systems were developed based on ISB standards, and the resulting carpal motions were discretised in flexion-extension. Custom software was used to register the CT data of the distal radius and carpal bones, which were scanned in air to obtain accurate cartilage geometry. The bones were aligned to reproduce their relative positions and orientations during passive wrist flexion-extension motions. The regions of overlap between the cartilaginous surfaces were quantified in an effort to estimate the resulting contact area. The depth of overlap was calculated to provide insight into the cartilage deformation during wrist motion, with the largest cartilage overlap defined as peak articular overlap. Outcome variables were contact area, as well as peak articular surface overlap. Statistical analysis was performed using a repeated measures ANOVA and paired t-tests with a significance level of  $p=0.05$ .

Wrist flexion-extension had no significant effect on contact area ( $p=0.49$ ). DA deformities of the distal radius did not have a significant effect on contact area ( $p=0.55$ ). Articular overlap between the capitate and lunate were not significantly different with wrist flexion-extension ( $p=0.43$ ), although articular overlap between the capitate and lunate increased as DA increased ( $p=0.025$ ).

Contact area was not significantly affected by wrist angle or DA, this may be due to the highly conforming nature of the capitulum joint. Peak articular overlap during wrist flexion-extension, which may be analogous to peak contact stress, significantly increased with greater DA of the distal radius. This may be indicative of a greater compression of the articular cartilage as DA deformity severity increases, resulting in increased peak contact stresses within the capitulum joint. These findings may elucidate why patients commonly report midcarpal pain with DA deformities.

## **55. ARTICULAR CARTILAGE REPAIR WITH MESENCHYMAL STROMAL STEM CELLS FOLLOWING CHONDROGENIC PRIMING IN NORMOXIC AND HYPOXIC CONDITIONS: A PRECLINICAL PILOT STUDY**

**Presenter: Troy D. Bornes, AB**

A. Adesida, AB, N. Jomha, AB

Bone marrow-derived mesenchymal stromal stem cells (BMSCs) are a promising cell source for treating articular cartilage defects. Quality of cartilaginous repair tissue following BMSC transplantation has been shown to correlate with functional outcome in a clinical setting. Therefore, tissue engineering and transplantation variables are currently under investigation with the goal of improving repair tissue quality and outcome. This preclinical study assessed a novel protocol that involved transplantation of BMSCs into full-thickness cartilage defects in sheep following isolation, expansion and a short period (four days) of chondrogenic priming. The impact of oxygen tension during pre-implantation culture was also investigated.

Ovine BMSCs were isolated, expanded to passage two, seeded within a hyaluronic acid (HYAFF) scaffold at 10 million BMSCs per cubic centimeter, and primed *ex vivo* in chondrogenic medium containing

transforming growth factor-beta three and dexamethasone for four days under normoxia (21% oxygen) or hypoxia (3% oxygen). Full-thickness, seven-millimeter-diameter articular cartilage defects were created in the medial and lateral femoral condyles of five sheep. Twenty defects were treated with normoxia-cultured BMSC-seeded scaffolds (eight), hypoxia-cultured BMSC-seeded scaffolds (eight), cell-free scaffolds (two), or no implants (two). Pre-implantation priming was evaluated through gene expression analysis using reverse-transcription quantitative polymerase chain reaction. After six months, histological assessment was performed on repair tissues with a modified O'Driscoll scoring system and tissue dimension analysis.

Priming of pre-implantation BMSC-seeded scaffolds in chondrogenic medium for four days resulted in significantly increased gene expression of hyaline cartilage-related collagen II, aggrecan and sex determining region Y-box nine (SOX9) relative to unprimed BMSCs ( $p < 0.05$ ). Chondrogenically primed BMSC-seeded scaffolds were shown to be capable of producing hyaline-like cartilaginous repair tissues that were rich in safranin O-positive proteoglycans. Defects implanted with primed BMSC-seeded scaffolds had significantly larger repair tissue areas, higher percentages of defect fill and improved modified O'Driscoll histological scores than cell-free controls ( $p < 0.05$ ). With respect to oxygen tension, a consistent difference in histological scores was not found between normoxia- and hypoxia-seeded BMSC-seeded scaffolds ( $p = 0.90$ ).

Chondrogenic priming of BMSCs for four days enhanced expression of genes associated with hyaline cartilage. BMSCs that were isolated, expanded and chondrogenically primed prior to implantation were capable of producing hyaline-like cartilaginous tissue that was superior to cell-free controls within full-thickness articular cartilage defects. Incubator oxygen tension during pre-implantation culture did not consistently modulate repair tissue formation in this model.

## **56. HIP MECHANICS AND MUSCLE ACTIVATION LEVELS DURING GAIT IN CAM-INDUCED FEMOROACETABULAR IMPINGEMENT COMPARED TO ASYMPTOMATIC INDIVIDUALS: A ROLE FOR GAIT ANALYSIS?**

**Presenter: Ivan Wong, NS**

J. Moreside, NS, D. Rutherford, NS

Arthroscopic surgery for CAM-induced Femoroacetabular Impingement (FAI) is increasingly prescribed for symptom management and correction of abnormal hip mechanics in young adults. Currently there is little evidence to aid understanding of the implications of FAI on hip function during gait. The purpose of this study was to compare three-dimensional (3D) hip motion, moments and hip muscle activation levels between symptomatic and contralateral limbs of individuals with FAI, and to determine if their symptomatic hip differed from a healthy asymptomatic group during walking.

Eighteen participants with unilateral symptomatic CAM-type FAI scheduled for arthroscopic surgery consented to participate, along with 20 age-matched asymptomatic controls. Using standardised procedures, surface electrodes were placed over gluteus maximus and medius bilaterally, medial and lateral hamstrings and rectus femoris. Participants walked at their preferred speed on an instrumented treadmill (MotekMedical). A Qualisys motion capture system recorded leg and pelvis motion. Electromyograms were collected using an AMT-8 EMG system (Bortec Inc.), low-pass filtered and amplitude normalised to maximum voluntary contractions. Euler rotations were used to derive 3D hip angles and net external moments were calculated using inverse dynamics. Knee (flexion and extension) and hip (flexion, extension, abduction and adduction) strength was measured during maximal contractions and passive range of motion (ROM) measured. Discrete measures were determined from gait waveforms. Independent and paired t-tests determined between group and within participant differences ( $\alpha = 0.05$ ).

In the FAI group, no differences between symptomatic and contralateral limbs were found for strength, 3D hip ROM or moments during gait ( $p > 0.05$ ) and only passive flexion ROM was less in the symptomatic hip ( $p = 0.004$ ). The FAI group walked slower, with lower knee and hip strength than the asymptomatic group ( $p < 0.05$ ).

The FAI group was weaker, walked slower and required a higher percentage of maximum hip flexor and extensor muscle activity to walk. 3D hip motion and moments did not differ when compared to the asymptomatic

group, and few differences existed between symptomatic and contra-lateral hips in those with FAI. Findings suggest lower extremity muscle function (strength and activation) is impaired bilaterally in individuals with FAI however these findings do not appear to directly influence biomechanical variables of walking associated with altered hip joint function; further stress tests (i.e. gait perturbations) are warranted.

## **57. BIOMECHANICAL AND RADIOGRAPHIC EVALUATION OF SUPRASPINATUS ANCHOR REPAIR AND THE EFFECT OF PRE-REPAIR CHANNELLING: A PROSPECTIVE RANDOMISED CONTROLLED ANIMAL STUDY**

**Presenter: Michael P. Grant, QC**

M. Albeshar, QC, L. Epure, QC, J. Antoniou, QC, F. Mwale, QC

Arthroscopic rotator cuff repair using anchors, the current standard of surgical care, continues to be associated with high dehiscence and re-tear rates. Advances in surgical techniques such as microfracturing and channeling the footprint at the time of repair seek to improve surgical outcomes by promoting stem cell recruitment and autologous healing factors, though preclinical evaluation to assess these advances remains limited. The objectives of this study were to 1) characterise healing longitudinally following anchor tendon repair in a rabbit model through quantitative biomechanical and radiographic outcomes and 2) test the efficacy of humeral footprint channelling performed one week before repair.

A supraspinatus (SSP) tenotomy was performed on one shoulder in 112 rabbits followed by channelling of the footprint (channelling group) in half of the rabbits while the other half was not channelled (no channelling group). One week later, the SSP tendon was repaired using a single lateral anchor. The repaired and intact contralateral tendons were harvested at zero, one, two or four weeks after repair. All specimens were subsequently imaged under 7T MRI to measure coronal footprint thickness, and mechanically tested to failure to assess strength, stiffness and failure mode in the three groups.

Mean load at failure and stiffness were  $81\pm 32\text{N}$  and  $27\pm 9\text{N/mm}$  respectively immediately after repair compared to  $166\pm 47\text{N}$  and  $66\pm 13\text{N/mm}$  in the contralateral shoulders (both  $p < 0.05$ ). The dominant failure mode shifted from the footprint at zero and one week after repair, to bone avulsion and mid-substance at four weeks ( $p > 0.05$ ). There were no significant differences in mean footprint thicknesses at one, two and four weeks post repair ( $p > 0.05$ ). Channeling of the footprint one week before repair did not improve any of the measured outcomes compared to the no channeling groups (all  $p > 0.05$ ).

Biomechanical properties and footprint thickness were stored at four weeks after anchor repair in the rabbit model model. Channelling of the SSP footprint one week prior to repair did not significantly improve the biomechanical or radiographic outcomes in the first four weeks after repair. Further refinement of footprint preparation is required in order to demonstrate the superiority of bone channelling in rotator cuff repair.

## **58. EFFECT OF LINK N ON THE SYNTHESIS AND DEGRADATION OF MATRIX PROTEINS IN HUMAN ARTICULAR OSTEOARTHRITIC CARTILAGE**

**Presenter: Motaz Alaqeel, QC**

M. Grant, QC, L. Epure, QC, O. Salem, QC, O. Huk, QC, J. Antoniou, QC, F. Mwale, QC

Osteoarthritis (OA) is a degenerative disease of the articular cartilage that affects millions of people. It is characterised by destruction and eventual loss of articular cartilage from affected joints, due to an imbalance in the anabolic and catabolic activities of chondrocytes. It is known that during the progression of OA, the proteoglycan network breaks down and biomechanical properties of healthy cartilage are lost... One catabolic cytokine presumed to be a principle mediator in OA is IL-1 $\beta$ . IL-1 $\beta$  can stimulate chondrocytes to produce matrix metalloproteinases, aggrecanases (ADAMTS) and suppresses the synthesis of aggrecan and collagen type II (Col II). Moreover, chondrocytes in OA express high levels of matrix metalloproteinase 13 (MMP-13), a main culprit in Col II and aggrecan degradation. The interaction between proteoglycans and hyaluronan is stabilised by link protein. It has previously been shown that Link N can stimulate the production of aggrecan in cartilage. We

have recently demonstrated that Link N can act as a growth factor and stimulate the synthesis of proteoglycans and collagen by human intervertebral disc model. However, it remains unknown if Link N can stimulate matrix production in human OA cartilage and whether it can modulate the catabolic actions of IL-1 $\beta$ .

Articular cartilage was isolated from five donors undergoing total hip/knee replacement. Cells were recovered from the cartilage of each femoral head or knee by sequential digestion with Pronase followed by Collagenase, and expanded in DMEM supplemented with 10% heat-inactivated FBS. Normal chondrocytes (PromoCell, Heidelberg, Germany) were expanded under the same conditions and used as control. After 7 days under standard cell culture conditions, cells were exposed to IL-1 $\beta$  (5 ng/ml), Link N (1  $\mu$ g/ml), and co-exposed to IL-1 $\beta$ +Link N for a duration of 12 days. Human articular cartilage explants were prepared from the same donors, and included cartilage with subchondral bone, and cultured in the presence of IL-1 $\beta$  (5ng/ml), Link N (1 $\mu$ g/ml) and IL-1 $\beta$  + Link N for 21 days. The release of GAG and the total GAG content were quantified using dimethylmethylene blue (DMMB) spectrophotometric analysis. Cartilage explants were characterised by changes in the expression of OA markers (MMP13, Col X, and IL-1 $\beta$ )by immunohistochemistry. Aggrecan fragmentation and Col II expression from cartilage explants were determined by Western blotting.

Treatment of OA cartilage or chondrocytes with Link N increased the synthesis of matrix proteins. The accumulative proteoglycan release and retention in OA chondrocytes and cartilage explants was higher with Link-N in comparison to control, as assessed by DMMB spectrophotometric analysis and Immunoblotting. As expected, when cartilage tissue and chondrocytes were incubated with IL-1 $\beta$ , matrix protein synthesis was decreased. However, when Link N was co-incubated with IL-1 $\beta$ , the effect of IL-1 $\beta$  on matrix protein synthesis was reversed. The expression of OA markers were also modulated by Link N (MMP-13, Col X and IL-1R), a property consistent with its ability in inhibiting IL-1 $\beta$  function

Our results suggest that Link N can supplement as a growth factor in OA cartilage, demonstrated by its ability to increase the production of cartilage matrix proteins, and behave as a chondroprotective agent, by modulating the catabolic effects of IL-1 $\beta$ .

## **59. APREPITANT INHIBITS MYOFIBROBLAST-MEDIATED COLLAGEN GEL CONTRACTION**

**Presenter: Kevin A. Hildebrand, AB**

M. Zhang, AB, P. Schneider, AB, P. Salo, AB, A. Befus, AB, M. Hollenberg, AB, D. Hart, AB

A myofibroblast-mast cell-neuropeptide (MMN) network has been associated with joint capsule fibrosis in post-traumatic joint contractures (PTJC). The neurokinin 1 (NK1) receptor is the preferred receptor for some relevant neuropeptides, such as substance P (SP). Aprepitant is an NK1 receptor antagonist. The purpose of our study was to determine if Aprepitant can inhibit the MMN network using an *in vitro* surrogate of PTJC, a collagen gel contraction assay.

Following research ethics approval, joint capsules were obtained from six patients with post-traumatic elbow contractures and six rabbit knees with surgically induced contractures. Isolated myofibroblasts (2.5 x 10<sup>5</sup> cells/mL) and the mast cell line HMC-1 (7.5 x 10<sup>5</sup> cells/mL) were incorporated into collagen gels. After gelation, the medium was changed to 500  $\mu$ L serum free DMEM/F12 with 1x serum replacement and 1x antibiotic-antimycotic, with varying concentrations of Aprepitant (1 x 10<sup>-6</sup>, 5 x 10<sup>-6</sup>, 1 x 10<sup>-5</sup>, 5 x 10<sup>-5</sup> M). An optimal concentration of SP was included in the solution (1 x 10<sup>-6</sup> M). The gels were incubated for 1h before being released, and were photographed at zero hours, two hours, four hours, six hours, 24 hours, 48 hours, and 72 hours post-release using a ChemiDoc XRS. The area of the gel was calculated using Image J. The gel contraction was expressed as a percentage of the gel diameter at zero hours. Statistical comparisons used a two way (treatment, time) ANOVA with a Post-hoc Tukey test. Significance was set at p $\leq$ 0.05.

The myofibroblast-mediated collagen gel contraction was slowed with the addition of all concentrations of Aprepitant in a concentration-dependent manner. This effect was evident by two hours post-release when compared to the control Aprepitant-free condition. Differences between concentrations of Aprepitant were significant at six hours and remained to 72 hours post-release. Aprepitant alone had no direct effect on the myofibroblasts in this assay. The results were similar for human and rabbit cells.



Aprepitant resulted in a concentration-dependent inhibition of myofibroblast-mediated collagen gel contraction. Mast cells must be present for Aprepitant to be effective in this surrogate model of PTJC. The Aprepitant effect was similar for human and rabbit myofibroblasts, which further validates our animal model with the human condition and facilitates future *in vivo* research. These results add support to previous reports establishing the MMN network as an underlying mechanism for joint capsule fibrosis. Aprepitant is an oral antiemetic used in cancer chemotherapy and post-operative regimens. Future experiments will evaluate Aprepitant in the rabbit knee model of PTJC. If results are promising, a randomised clinical trial (RCT) will be performed. Our previous research on Ketotifen, a mast cell stabiliser, has proceeded through these *in vitro* and *in vivo* methods, and is currently being evaluated in an RCT. Repurposing established drugs such as Aprepitant or Ketotifen can quickly introduce new safe and cost-effective treatments.

## **60. CYTOKINE PROFILES AS POTENTIAL BIOMARKERS FOR "PRE-OSTEOARTHRITIS"**

**Presenter: Guomin Ren, AB**

J. Whittaker, AB, P. Railton, AB, J. Powell, AB, C. Emery, AB, R. Krawetz, AB

Osteoarthritis (OA) is the most common arthritic disease leading to disability. Joint trauma and bone abnormality are potential risk factors for developing OA. Specifically, studies have shown that ~50% of individuals with a knee injury go on to develop knee OA. Hip impingement and dysplasia are reportedly associated with the development of hip OA. Due to these risk factors, there is believed to be a "pre-OA" stage when cellular processes are underway, but have not resulted in phenotypic/morphologic changes that can be detected by current diagnostics. While new techniques such as T1p MRI can quantify early changes of the joint tissue, these still require some level of tissue remodeling to have occurred. Although a number of biochemical markers have been investigated in clinically diagnosed OA patients, very few studies have reported reliable biomarkers for patients with suspected "pre-OA". In this study we aim to find out if there is any relationship between serum cytokines and "pre-OA" signs.

Fifty participants who sustained a youth sport-related intra-articular knee joint injury, 50 age, sex and sport matched controls and 12 patients with hip abnormality (impingement or dysplasia) were included in this study. Bone marrow lesion (BML), cartilage, meniscus, ligament and synovitis in both injured and non-injured knees were evaluated using MRI OA scores (MOAKS). MRI-defined OA was based on established criteria using MOAKS. Cytokine profiles (include 41 cytokine concentrations) in serum samples were analysed using the Human Cytokine Panel (Millipore) on the Luminex platform. Synovium tissues harvested from hip abnormality patients were probed for CCL22, IP10 and TNF $\alpha$  using immunohistochemistry methods. The correlations between cytokines and MOAKS were assessed using Spearman's correlation test with a false discovery rate of 0.01. The differences in cytokine profiles between participants with and without MRI-defined OA were tested using multivariate analysis of variance.

Thirteen cytokines were correlated with MOAKS. Cytokine profiles were different between participants with and without MRI-defined OA (<0.0001). To test if these systemically detected cytokines could be coming from the joint, CCL22, IP10 and TNF $\alpha$  expressions were examined in synovial membrane biopsies from the hip abnormality patients and were found to be present.

We have shown that 13 serum cytokines correlate with MOAKS and the cytokine profiles differ between participants with and without MRI-defined OA. These results suggest that cytokines might be potential biomarkers of early joint deterioration. We also observed that CCL22, IP10 and TNF $\alpha$  were present in synovium tissues in patients with hip abnormality. This indicates that these cytokines may play a role in the progression of pre-OA to OA in the hip. Overall, we have provided preliminary evidence that suggests that specific cytokines may be valuable as potential biomarkers for the "pre-OA" stage of the disease.

## COA Adult Reconstruction Hip 1

### **61. LOW DOSE INTRA-ARTICULAR TRANEXAMIC ACID REDUCES HEMOGLOBIN DROP AND D-DIMER FORMATION AFTER TOTAL HIP AND KNEE REPLACEMENTS: DOUBLE BLINDED RCT**

**Presenter: Eric Bohm, MB**

T. Turgeon, MB, D. Hedden, MB, C. Burnell, MB, S. Aragola, MB

Tranexamic acid has had a major impact on blood loss and transfusion rates following joint arthroplasty. Despite this, there is still controversy as to the most effective dose, dosing technique, and risk of thrombotic events. Attempts have been made to reduce the dose by using a bath containing tranexamic acid at the end of the case. Intra-articular injection of a reduced-dose solution of tranexamic acid after wound closure has not been studied.

A double-blinded randomised placebo-controlled trial was carried out on consented subjects. Subjects underwent either a primary unilateral total knee arthroplasty or primary unilateral hip arthroplasty and were free from bleeding diatheses and anemia. Subjects underwent the treating surgeon's standard surgical technique. Subjects were randomised to receive either saline solution or the saline solution with 0.5g of tranexamic acid. After fascial closure, a 50 mL solution of saline was injected into the joint space. All physicians involved with the patient's care were blinded to the injected solution. All total knees were carried out with cemented fixation. All hips were carried out using uncemented implants. Hemoglobin was measured pre-operatively and post-op day one for all subjects. Any subjects still in hospital on post-op day two and three also had additional hemoglobin values. Troponin serum values were measured every six hours for the first 24 hours. D-dimer levels were measured on post-op day one and post-op day two.

A total of 127 subjects were enrolled in the study (67 knee and 60 hip cases). There were no differences between the groups in terms of gender, weight, height, BMI, or pre-operative hemoglobin. Despite randomisation, age did differ between the two groups with the tranexamic acid group being a mean of five years older than the placebo group. The hemoglobin level on post-op day one did not differ between the two groups, however the calculated blood loss based on the difference between pre-operative and post-operative day one hemoglobin values did differ with a mean loss of 880mL for the treatment group and 1075mL for the placebo controlled group ( $p=0.026$ ). Post-operative day two hemoglobin values were also statistically different with mean hemoglobin of 112 in the treatment group and 106 in the placebo control. No transfusions were given in either group during the study. There were no differences between the groups in the troponin levels. The d-dimer levels were significantly reduced in the treatment group on both post-op day one and post-op day two by 35% and 45%, respectively ( $p=0.015$ ,  $p<0.001$ ).

The intra-articular injection of tranexamic acid at a lower dose appears to be safe and still reduce the drop in post-operative hemoglobin. Given the low rates of transfusion, this study was unable to detect a difference in transfusion rates. The lack of any changes in the troponin group suggests cardiac safety with this approach as does the reduction in the d-dimer levels with the use of tranexamic acid locally.

### **62. A TRIAL OF FRACTURE FIXATION IN THE OPERATIVE MANAGEMENT OF HIP FRACTURES**

**Presenter: Emil Schemitsch, ON**

FAITH Investigators, ON

High rates of re-operations after initial hip fracture fixation, the associated morbidity, mortality, and costs motivated the Fixation using Alternative Implants for the Treatment of Hip fractures (FAITH) randomised controlled trial.

We randomised 1,079 patients with a low-energy hip fracture requiring fracture fixation in 81 centres to a single large diameter screw with a side-plate (sliding hip screw) or the current standard, multiple small diameter cancellous screws (Clinical Trials Identification Number: NCT01908751). The primary outcome was hip re-operation within 24 months. Health-related quality of life (HRQL) was measured by the SF-12, EQ-5D, and WOMAC score.

Re-operations did not differ by type of surgical fixation: 107 of 542 patients (19.7%) in the sliding hip screw group and 117 of 537 patients (21.8%) in the cancellous screws group (hazard ratio, 0.83; 95% CI, 0.63 to 1.09;  $p=0.18$ ). Avascular necrosis was more common in the sliding hip screw group than in the cancellous screws group (50 patients [9.2%] vs. 28 patients [5.2%]; hazard ratio, 1.78; 95% CI, 1.09 to 2.91;  $p=0.02$ ). The three HRQL instruments were consistent in showing no important difference by treatment group at 24 months. *A priori* subgroups suggested lower re-operation rates with sliding hip screws in patients with displaced fractures (interaction  $p=0.04$ ), base of femoral neck fractures (interaction  $p=0.04$ ), and current smokers (interaction  $p=0.02$ ); current smoking appeared the dominant effect modifier in an analysis that included all three variables.

Among patients with a hip fracture there was no convincing difference in hip re-operations or HRQL among patients allocated to sliding hip screw compared to cancellous screws. Avascular necrosis was higher with sliding hip screws.

### **63. SIMULTANEOUS VS. STAGED BILATERAL TOTAL JOINT ARTHROPLASTY: A MATCHED COHORT STUDY**

**Presenter: Raghav Saini, AB**

Hoang Kong, AB, C. Smith, AB, S. Mahdavi, AB, S. Puloski, AB, J. Powell, AB, R. Sharma, AB, K. Johnston, AB

There is often reluctance to offer simultaneous bilateral total joint arthroplasty due to the perceived higher incidence of post-operative medical complications. Utilising a province-wide database, we compared patients undergoing bilateral simultaneous total hip and bilateral simultaneous total knee arthroplasty to patients who had undergone staged bilateral hip and knee arthroplasty respectively. We specifically looked at whether there is an increase in post-operative complications, length of stay (LOS), blood transfusion and 30-day readmission rates among the simultaneous bilateral group.

Our study included 1645 patients who had undergone bilateral total hip arthroplasty (BTHA) and 4125 patients who had undergone bilateral total knee arthroplasty (BTKA) between April 1, 2009 and January 31, 2016. The number of patients who had undergone simultaneous BTHA and BTKA were 204 and 310 respectively. To minimise the effect of selection bias, we matched the simultaneous BTHA and BTKA patients with staged BTHA and BTKA respectively for age, gender and number of pre-surgical risk factors using propensity score. We were able to find a closest perfect match for 195 patients of simultaneous BTHA and for 302 patients of simultaneous BTKA group in a matching ratio of 1:1. We compared the post-operative medical complications, length of hospital stay, blood transfusion, and 30-day readmission rates between simultaneous and staged cohorts for both hip and knee groups.

Simultaneous bilateral hip and knee arthroplasty was performed more frequently in younger, healthier and male population cohort. There is no significant difference in post-operative medical complications between simultaneous and staged BTHA matched cohort groups (adjusted OR[1.3],  $p=0.73$ ). However, simultaneous BTHA cohort had statistically significant shorter length of stay (adjusted difference LOS= -1.8 days,  $p<0.001$ ) and higher odds for blood transfusion (adjusted OR[4.3],  $p<0.001$ ). As compared to the matched staged BTKA cohort. Different from the BTHA group, we found no difference in 30-day readmission rate (adjusted OR[0.6],  $p=0.3$ ) between simultaneous and staged BTKA matched cohorts.

Simultaneous BTHA and BTKA have comparable post-operative medical complications with the additional benefits of shorter length of hospital stay compared to staged procedure. However, due to the higher odds of receiving a blood transfusion, this may be reserved for patients without baseline anemia.

### **64. IS ORTHOPAEDIC DEPARTMENT TEACHING STATUS ASSOCIATED WITH ADVERSE OUTCOMES OF PRIMARY TOTAL HIP ARTHROPLASTY?**

**Presenter: Emmanuel Illical, NY**

M. Boylan, NY, Q. Naziri, NY, F. Segreto, NY, R. Elmallah, NY, C. Paulino, NY, M. Mont, NY, D. Perfetti, NY

The purpose of this study is to compare outcomes of patients undergoing total hip arthroplasty between teaching vs. non-teaching in regard to complications and 90-day readmission.

A total of 60,894 patients underwent primary total hip arthroplasty between January 1, 2009 and September 30, 2012 in the New York Statewide Planning and Research Cooperative System.

Perioperative medical and surgical complication categories were created using ICD-9-CM diagnosis codes. Medical complications included acute myocardial infarction, pulmonary embolism, pneumonia, acute renal failure, deep vein thrombosis, sepsis, urinary tract infection, and stroke. Surgical complications included wound hemorrhage, wound disruption, wound infection, implant infection, irrigation and debridement, and post-operative dislocation. Costs were calculated using cost-to-charge ratios. Mixed-effects regression models accounted for hospital clustering and year of surgery and were controlled for age, gender, race, insurance, major complication or comorbidity status, and Deyo comorbidity score.

Mean length of stay was longer at teaching compared to non-teaching hospitals (3.77 vs. 3.71 days;  $p=0.002$ ), and this difference remained significant in regression modeling (beta: 5.2%,  $p=0.007$ ). Perioperative medical complications were less common at teaching compared to non-teaching hospitals (3.7% vs. 4.7%;  $p<0.001$ ) but this was not significant in regression modeling (OR=0.88,  $p=0.122$ ). Perioperative surgical complications were similar at teaching compared to non-teaching hospitals (0.8% vs. 0.9%,  $p=0.130$ ), remaining insignificant after regression modeling (OR=0.99,  $p=0.948$ ). Mean costs were higher at teaching compared to non-teaching hospitals (21,568 vs. 19,579 USD;  $p<0.001$ ) and this difference remained highly significant in adjusted regression modeling (beta: 15.3%,  $p<0.001$ ). Disposition to inpatient rehabilitation was more common at teaching compared to non-teaching hospitals (20.4% vs. 14.2%,  $p<0.001$ ), remaining significantly different in adjusted regression modeling (OR=2.40,  $p<0.001$ ). The rate of unplanned 90-day readmission was less common with patients undergoing THA at teaching compared to non-teaching hospitals (6.1% vs. 7.2%,  $p<0.001$ ), but this difference was not significant after adjusted regression modeling (OR=0.95,  $p=0.249$ ).

Primary total hip arthroplasty at teaching hospitals is associated with higher costs, increased length of stay and increased utilisation of inpatient rehabilitation facilities. Teaching hospitals did not significantly differ from non-teaching hospitals in terms of inpatient complications or unplanned 90-day readmission. These findings suggest that orthopaedic teaching hospitals may be adversely affected by regional pricing. While indirect medical education payments help defray the costs of inefficiency in United States teaching hospitals, administrators and policy makers must ensure that financial incentives for efficiency are not impeding resident education.

## **65. COMPARISON OF COBALT AND CHROMIUM RESULTS FROM TWO CANADIAN LABORATORIES**

**Presenter: Raghav Saini, AB**

J. Boyd, AB, P. Railton, AB, P. Faris, AB, H. Sadrzadeh, AB, J. Powell, AB

Metal-on-Metal (MoM) prosthesis for hip replacement have proven to be popular as they exhibit less wear than their metal on polyethylene counterparts. Following MoM joint replacement, it is expected that the levels of cobalt and chromium, become elevated in the blood. The surgeon may monitor blood levels as an indicator of implant failure and/or to assess for possible toxicity. At present, there is little consensus on the use of blood cobalt and chromium measurements, especially with respect to the specimen of choice (whole blood vs. serum). In addition, we have found inconsistencies in reported results from different labs. Our lab recently switched referral labs for trace metals testing from Lab A, who performed cobalt and chromium in whole blood, to Lab B, who measures cobalt in whole blood and chromium in serum. Here we present the results of a study comparing the cobalt and chromium results from these two labs.

Lab A and B are both located in Canada and use inductively coupled plasma-mass spectrometry (ICP-MS) for trace element analysis. Patients with existing MoM hip replacement being monitored by orthopaedics were included in the study. Following their regular blood draw for whole blood cobalt and serum chromium which was sent to Lab B as per normal laboratory protocol. An aliquot of the whole blood tube was taken and sent to Lab A for whole blood chromium and cobalt analysis. Results were collated and analysed using our in house patient comparison spreadsheet.

Results have been obtained from 68 patients with a MoM joint replacement. Whole blood cobalt comparisons between Lab A and B had an R2 value of 0.9969 ( $y=0.79x + 2.163$ ) and displayed a bias towards Lab A. With cobalt concentrations below 100 mmol/L, the percent bias ranged from +10% to -30%. Above 100 ng/mL, the percent bias was consistent at -20%. This was of interest as we expected better agreement between the two labs when using the same specimen type. The comparison of whole blood chromium (Lab A) to serum chromium (Lab B) showed a clear positive bias towards Lab B ( $R2 = 0.9944$ ;  $y=1.41x-5.05$ ). The majority of chromium values obtained were below 100 ng/mL and exhibited a % bias ranging from -30% to +60%. Two patients were collected with values above 150 ng/mL and had percent biases of +40 and +58%.

Cobalt and chromium measurements can differ substantially between labs, even when using the same specimen type. Surgeons need to be aware that these differences can exist when guiding clinical care.

## **66. THE ASSOCIATION BETWEEN HOSPITAL ARTHROPLASTY SURGICAL VOLUME AND PATIENT OUTCOMES**

**Presenter: Jason Werle, AB**

H. Khong, AB, C. Smith, AB

It is postulated that high-volume arthroplasty hospitals (>300 cases/year) will have markedly improved patient outcomes than hospitals that carry out a lower volume of these procedures. The trend toward focussed centres of excellence is widespread and yet few studies compare the outcomes of different care delivery models to one another. This study was designed to compare risk-adjusted outcomes of patients receiving arthroplasty surgery in low and high-volume centres.

This study evaluates the outcomes of all patients undergoing primary total hip, primary total knee, hip resurfacing, or unicompartmental knee arthroplasties in 13 hospitals in Alberta from Jan. 1, 2010 to Dec. 31, 2014. Hospital volume was divided into low ( $\leq 300$  arthroplasties per year) and high (>300/year). Outcome measures included acute and total length of stay (LOS), inpatient mortality rates, WOMAC at three months post-op, EQ5D at three months post-op, transfusion rates, deep infection rates, mechanical adverse events, medical adverse events, and readmission rates. Outcomes were risk-adjusted for age, gender, procedure, and pre-surgery risk factors. Chi-square test was used to compare categorical variables in two or more groups. Exact-test was used to compare very rare events (ie. mortality). T-test was used to compare the means of two groups and Anova was used to compare the means of three or more groups.

A total of 38,755 patients were included in this study at 13 hospitals. The surgeries were performed by a total of 88 different surgeons. Procedures performed at low-volume hospitals totaled 4,233 and totaled 34,522 at the high-volume hospitals. The pre-surgery risk factors were not significantly different between the two hospital groups. There were no significant differences in pre- or post-op WOMAC or EQ5D patient reported outcomes between the two hospital groups. There were no significant differences in inpatient mortality, medical adverse events, or deep infection rates between the low-volume or high-volume hospital groups. Low-volume hospitals had significantly lower Acute LOS (3.9 days vs. 4.3 days,  $p<0.001$ ).

This study compares the outcomes of primary arthroplasty surgery performed at low-volume ( $\leq 300$ /year) and high-volume (>300/year) hospitals in Alberta. It is reassuring that the results for patient reported outcome measures, inpatient mortality, medical adverse events, and infection rates were similar regardless of hospital volume. LOS was better at small volume hospitals. This may be related to focussed nursing teams, available home care, and care path utilisation and adherence. Transfusion rates, mechanical adverse event rates, and readmission rates were better at high-volume hospitals.

## **67. RISK FACTORS FOR INFECTION, REVISION, MORTALITY, BLOOD TRANSFUSION AND LONGER HOSPITAL STAY AFTER PRIMARY TOTAL HIP OR KNEE ARTHROPLASTY AT THREE MONTHS AND ONE YEAR POST-OPERATIVELY**

**Presenter: Chanseok Rhee, NS**

L. Lethbridge, NS, G. Richardson, NS, M. Dunbar, NS

Total joint replacement (TJR) is increasingly performed in older and more comorbid. These populations are considered high risk for post-operative complications, yet little information is available to provide individualised risks of complications as a part of the informed consent process. In this study, we identified and calculated the odds ratio of the risk factors for infection, revision and mortality at three months and one year after TJR, and also for post-operative blood transfusion and prolonged admission.

We analysed all primary hip and knee arthroplasty cases in Nova Scotia, Canada, during the fiscal years 2001-2013, as identified from the hospital Discharge Abstract Database. The Charlson co-morbidity index was used to include medical conditions to be included in the analysis. Hospital and physician billings data as well as Nova Scotia Vital Statistics data were used to identify the post-operative events in this cohort. Multivariate regression analysis was used to examine individual associations between risk factors and patient outcomes and associations are presented as odds ratios (ORs).

In total, there were 9,131 primary total hip arthroplasty (THA) and 15,432 primary total knee arthroplasty (TKA) cases performed during the study period. Significant risk factors for infection were heart failure (OR=5.8 at three months and 4.7 at one year) and diabetes (OR=1.8 at three months) for THA, and mild liver disease (OR=4.5 at three months and 4.6 at one year) and transfusion (OR=1.7 at one year) for TKA. Revision rates were higher for patients with rheumatologic disease (OR=2.3 at three months and 2.0 at one year) and paraparesis/hemiparesis (OR=11.1 at three months and 5.4 at one year) for THA, and patients with metastatic disease (OR=9.0 at three months and 3.2 at one year) for TKA. Significant risk factors for mortality included metastatic disease, 80 years of age or older, heart failure, myocardial infarction, dementia, rheumatologic disease, renal disease, blood transfusion, and cancer. Multiple medical comorbidities such as diabetes, myocardial infarction, heart failure, ischemic heart disease, osteoarthritis, dementia, rheumatologic disease, peptic ulcer disease, renal disease and cancer, and older age were associated with increased rate of blood transfusion, and there was significant variability in transfusion rates among the different hospitals. The average length of hospital admission after TJR has been decreasing during the study period, with multiple medical conditions, transfusion, older age and female sex being associated with longer hospital stay.

The current study identified the risk factors associated with higher rates of post-operative complications and longer admission after TJR. Furthermore, the OR of each risk factor for the related post-operative complication was calculated. The results from this study allow individualised risk stratifications during the pre-operative consultation.

## **68. REVISION RISK CURVES FOR HIP AND KNEE REPLACEMENTS FROM THE CANADIAN JOINT REPLACEMENT REGISTRY**

**Presenter: Carolyn Sandoval, ON**

K. Molodianovitch, ON, E. de Sa, ON, N. De Guia, ON, G. Webster, ON, M. Dunbar, NS, E. Bohm (on behalf of the Scientific Advisory Committee of the CJRR), MB

To present revision risk curves for hip and knee replacements based on national data sources for joint replacement data. Assessing time to revision for hip and knee replacement patients and risk factors involved can help inform clinical and health care system improvements.

Primary hip and knee replacements performed between April 1, 2012 and March 31, 2015 were obtained from the Canadian Joint Replacement Registry (CJRR). Only data from mandated provinces (British Columbia, Manitoba and Ontario) were included, thus ensuring high coverage (>90%). The first revision was captured using CIHI's Discharge Abstract Database (DAD) and National Ambulatory Care Reporting System (NACRS), which contain all hip and knee joint replacements performed in Canada (inpatient and day surgery). End of follow-up was March 31, 2015. Cumulative revision risk is presented via survival curves using the Kaplan-Meier method. Results are presented by gender, age, type of procedure and type of femoral fixation (where available).

This analysis provides a high-level view of the revision risk over the first three years by patient and surgical characteristics. While the cumulative revision is relatively low at three years post-operatively for both hip

and knee replacements, there are some differences in revision risk by age group at one-year and two-years. The cumulative revision rate after two-years for all types of partial knee replacements was significantly higher than for total knee replacements. Hip arthroplasty for fracture undertaken with cementless fixation had a higher two-year revision risk than cemented fixation.

This analysis lays the foundation for further patient and implant sub-group analyses and for informing clinical and procurement functions related to these prostheses and approaches. It also highlights the value of collecting clinical and prosthesis information at the national level, allowing for longitudinal analysis of patients who undergo hip and knee replacements. Such analyses can help inform clinical and system-level decisions, which can lead to improvements in the quality of joint replacement surgeries, result in improvements in patient outcomes and reduce the cost of revision surgeries.

## **69. A RETRIEVAL ANALYSIS TO DETERMINE THE VIABILITY OF HIP RESURFACING CONVERSION TO DUAL-MOBILITY PROSTHESES**

**Presenter: Brent Lanting, ON**

T.C. Gascoyne, MB, T. Turgeon, MB, M. Teeter, ON

Revision of a hip resurfacing prosthesis may involve the retention of the acetabular component, should it be found to be well-fixed. In such cases, physicians have opted to pair the retained acetabular component with a dual-mobility prosthesis for the revision construct. There is little documentation of *in vivo* wear and damage present on these acetabular components and thus the long-term implications are unknown regarding wear of the dual-mobility prosthesis against the retained cup. The purpose of this study was to analyse retrieved hip resurfacing components to document their damage patterns, assess the *ex vivo* surface finish, and quantify dimensional changes as a result of wear.

Implant retrieval databases in London, ON and Winnipeg, MB collaborated to identify patients who underwent revision of their Birmingham Hip Resurfacing (BHR) between 2004 and 2016. Patient data were collected from clinical databases and hospital charts, including; age, gender, body mass index (BMI), time *in vivo*, and reason for revision. Analysis was performed on the retrieved acetabular components in the following three stages; 1) damage characterisation and scoring performed by three observers, 2) contact profilometry of identified damage areas, and 3) surface reconstruction through coordinate measurement machine to quantify dimensional changes of the bearing surface due to wear.

Thirty retrieved BHRs were retrieved from 11 females, 19 males with a mean age of 62 years (SD 6.6) and mean BMI of 30.7 kg/m<sup>2</sup> (SD: 6.9). Time *in vivo* was on average 4.9 years (SD: 2.1 years) with reasons for revision including those related to the metal-on-metal bearing (9), infection (7), unexplained pain (5), and others (9). All retrievals showed scratching damage with 25 of 30 having >50% coverage of the bearing surface. Other damage features were less common; grooves 26 of 30 samples, pitting 14 of 30, metal transfer nine of 30, and stripe wear 15 of 30. Average surface roughness in scratched regions was 0.04 µm, compared to 0.10 µm, 0.07 µm, 0.19 µm, and 0.03 µm in grooved, pitted, metal transfer, and stripe wear areas. Significant cup wear was measured in 12 of 30 retrievals, with a mean diametric change of 0.20 mm (SD: 0.12 mm).

The high occurrence of damage on the retrieved BHR implants, coupled with the increased surface roughness suggests that conversion to a dual-mobility bearing may not be advisable in the long-term. *In vitro* studies have shown that surface roughening can increase polyethylene wear by 6-10x compared to the pristine condition. Further, diametric change of the bearing couple can increase contact stress on the polyethylene, risking further wear and possible delamination. Hip instability, osteolytic-particle burden, and component dissociation may become concerns in the long-term for these patients. Additional work is underway to determine which patients may be appropriate candidates for conversion to dual-mobility prostheses.

## **70 - Intravenous and Topical Tranexamic Acid in Primary Total Hip Arthroplasty: The Tranexamic Acid Comparison in Hip Replacement (TeACH-R) Randomised Controlled Trial**

**Presenter: Richard Nadeau, BC**

J. Howard, ON, F. Ralley, ON, L. Somerville, ON, D. Naudie, ON

Tranexamic acid (TEA), administered via either the intravenous or topical route, has been shown to reduce peri-operative blood loss and allogeneic blood transfusion. However, there are very few prospective randomised controlled trials comparing the relative efficacy of TEA administered *via* either of these routes. The purpose of this study was to determine whether there is any clinically significant difference in blood loss after intravenous or topical TEA administration during primary total hip arthroplasty (THA).

The Tranexamic Acid Comparison in Hip Replacement (TeACH-R) randomised controlled trial is a blinded prospective study of 124 participants undergoing primary cementless THA. Sixty-seven participants received a weight-based bolus infusion of intravenous TEA (20 mg/kg) ten minutes prior to skin incision, and 57 participants received a 1.5-gram dose of topical TEA infiltration at the time of arthrotomy closure. Peri-operative hematocrit levels were used to calculate and compare the total volume of blood loss. The peak post-operative change in hemoglobin from baseline ( $\Delta$ Hgb) and number of blood products transfused were used as secondary outcome measures. A tertiary outcome was the measurement of plasma levels of tranexamic acid ( $\mu$ g/ml) by tandem mass spectrometry one hour after administration. Participants were followed for three months after THA in order to capture any postoperative complications.

There was no significant difference in mean peri-operative blood loss for those participants having received either topical or intravenous TEA ( $1431 \pm 503$  mL and  $1449 \pm 507$  mL, respectively;  $p=0.811$ ). Peak  $\Delta$  Hgb was  $33 \pm 13$  mg/dL for the intravenous group, and  $33 \pm 12$  mg/dL for the topical group ( $p=0.858$ ). Two participants, one in each treatment arm, required a transfusion of packed red blood cells post-operatively. Plasma levels were drawn from 29 patients who received IV TEA, and from 15 patients who received topical TEA. Those participants receiving topical TEA had four-fold lower TEA levels at one hour post-operatively (mean  $12.44 \pm 17.59$  versus  $52.54 \pm 23.94$   $\mu$ g/mL,  $p=0.000$ ). No symptomatic thromboembolic events were noted in either treatment group during the 3-month follow-up period.

Topical and intravenous TEA show similar clinical efficacy in reducing peri-operative blood loss after primary THA. While there are advantages to administering TEA intravenously, the results of this study suggest that topical administration offers similar efficacy with significantly lower circulating plasma levels of TEA. The relationship between circulating TEA levels and the incidence of complications, such as venous thromboembolic events, remains unclear and requires further study.

### **Tumour**

## **71. INVESTIGATING THE ONCOLYTIC EFFECT OF MARABA VIRUS [MG1] AGAINST SARCOMA: *IN VITRO*, *EX VIVO* AND *IN VIVO***

**Presenter: Hesham Abdelbary, ON**

F. Le Boeuf, ON, J-S. Diallo, ON, J. Werier, ON, D. Butterwick, ON

Advanced bone and soft sarcoma remain challenging to treat with standard regimens available due to the heterogeneity of the disease. Oncolytic viruses (OV) has shown great promise in a number of clinical trial against broad spectrum of tumour types. However potential therapeutic benefit of OV in sarcoma still need to be demonstrated. Only a few pre-clinical studies have evaluated the efficacy of OV therapies in sarcoma models. In this study, we evaluate the oncolytic potential of a subset of promising OV in parallel against human sarcoma cell lines and human sarcoma explants obtained following surgery. The most effective OV based on those results was subsequently tested in an immunocompetent animal sarcoma model.

Three OV platforms were screened for their ability to infect and kill sarcoma cells using *in vitro* human sarcoma cell lines, murine *in vivo* model as, well as 21 human sarcoma live ex-vivo tissues. Herpes Simplex virus



(HSVn212-eGFP), Reovirus (Reolysin), Vaccinia virus (VVdd-eGFP) and two Rhabdoviruses, Vesicular Stomatitis Virus (VSVd51-eGFP) and Maraba virus (MG1-eGFP) were used. The susceptibility of four different sarcoma cell lines, human Osteosarcoma (143B), Canine Osteosarcoma (D17), human Ewing's sarcoma (RD-ES) and human synovial sarcoma (SW982) were tested against the panel of OV. EC50 values were then determined for each OV. For the *in vivo* model, S180 (1x10<sup>6</sup>) tumours were established subcutaneously in immune-competent Balb/C mice (N=10 per group). Palpable tumours formed within 11 days after seeding. Maraba MG1 virus was administered (1x10<sup>7</sup>pfu/mouse).

Twenty-one individual samples were processed corresponding to various types of sarcoma as: osteosarcoma OST (29%), undifferentiated pleomorphic sarcoma UPS (24%), chondrosarcoma CDS (14%), leiomyosarcoma LMS (10%), rhabdomyosarcoma RMS (5%) and other types of sarcoma O (19%). Comparing this data, MG1 was clearly more effective than Vaccinia in its capacity to productively replicate in human sarcoma tissues across the board. MG1 clearly kills sarcoma cells *in vitro*, infected and replicated in more than 80% of human sarcoma tissues tested. Treatment of S180 *in vivo* model using MG1 strongly increased the outcome with 80% cured mice (11/15; Pvalue=0.0276) by slowing down the progression of the tumour.

This study demonstrated that oncolytic MG1 had therapeutic potential against sarcoma cells. It is still unclear whether there will be a direct correlation between infection of *ex vivo* patient tissue and anti-tumour effect in sarcoma patients. This study can open the door to further clinical research to explore the potential of MG1 in treating sarcoma patients.

## **72. IDH1 AND IDH2 MUTATIONAL ANALYSIS CAN HELP DISTINGUISH BETWEEN CHONDROBLASTIC OSTEOSARCOMA AND DEDIFFERENTIATED CHONDROSARCOMA IN HISTOLOGICALLY AMBIGUOUS CASES**

**Presenter: Eyal M. Ramu, ON**

Q. Wei, ON, K. Gundle, OR, A. Griffin, ON, B. Dickson, ON, R. Kandel, ON, P. Ferguson, ON, B. Alman, NC, J. Wunder, ON

Distinguishing chondrosarcoma (CSA) from osteosarcoma (OS) can be challenging in the setting of a biopsy specimen. The diagnosis is critical for appropriate treatment decision making and prognosis. The treatment for OS is neoadjuvant chemotherapy and surgical resection; however CSA is treated by surgical resection alone. The chondroblastic subtype of OS contains both chondroid matrix and osteoid-forming tumour areas, as such sampling errors can lead to an erroneous diagnosis of chondrosarcoma if the chondroid portion of the tumour is sampled. Similarly, the dedifferentiated subtype of CSA contains a non-cartilaginous component, commonly resembling osteosarcoma. Sampling the non-cartilaginous component can result in an erroneous diagnosis of OS, leading to significant implications for treatment. Mutations in the Isocitrate dehydrogenase genes (IDH1 and IDH2) have been described in a variety of tumours, recently in CSA. Currently, no IDH1 or IDH2 mutations have been identified in OS. The purpose of this study was to determine if IDH mutational status could be used to differentiate between patients with OS and CSA when biopsy results are equivocal.

Five patients with primary high grade bone tumours based on radiological imaging, but with ambiguous histological diagnoses between OS and CSA based on biopsy results were analysed. The genomic DNA of each tumour was prospectively assessed for IDH1 and IDH2 mutations using Capillary Sanger sequencing after PCR amplification of exon 4 of both genes.

IDH mutations were identified in three tumours, one in IDH1 and two in IDH2, while in two cases the IDH genes were found to be wild type. The two patients with wild type IDH1/2 tumours were younger (< age 30) and had radiological imaging that was more consistent with OS. The three patients with the IDH1 and IDH2 mutations were older (> age 60) and had radiological imaging more consistent with CSA. One patient, with a tumour harboring a mutated IDH1, was initially treated with neoadjuvant chemotherapy due to the initial histological diagnosis of OS with chondroblastic differentiation. However, the chemotherapy was stopped due to continued growth of the tumour. Following surgical resection, histological analysis based on evaluation of the resected

tumour was changed to dedifferentiated CSA. This diagnosis would explain the lack of response to chemotherapy and was consistent with the presence of an IDH1 mutation.

Our study supports the use of IDH1 and IDH2 mutation analysis in cases where the diagnosis is not in keeping with the imaging and there is concern that the biopsy is unable to distinguish between chondroblastic OS and dedifferentiated CSA. Interestingly, recent *in vitro* studies in which transfection of mutant IDH genes into mesenchymal stem cells led to upregulation of only chondroid markers of differentiation(1) which may explain the mechanism whereby IDH mutation may result in these histological features. References: 1. Jin Y et al, PlosOne, PMID 26161668.

### **73. BARRIERS AND FACILITATORS EXPERIENCED IN COLLABORATIVE PROSPECTIVE RESEARCH IN ORTHOPAEDIC ONCOLOGY**

**Presenter: Michelle Ghert, ON**

M. Swinton, ON, S. Rendon, ON, N. Bernthal, CA, N. Evaniew, ON, P. Ferguson, ON, P. McKay, ON, B. Miller, IA, P. Schneider, ON, R. Velez, Spain, K. Weiss, PA, J. Zumarraga, Brazil, T. Damron, NY, M. Serra, Argentina, M. Boffano, Italy, W. Hettwer, Denmark, L. Nystrom, IL, W. Parizzia, Argentina, A. Spiguel, FL

Due to the rarity of bone and soft-tissue malignancies, multicentre prospective collaboration is essential for broadly meaningful research and evidence-based advances in patient care. The objective of this study was to identify barriers and facilitators encountered in large-scale collaborative research by orthopaedic oncology surgeons involved or interested in prospective multicentre collaboration.

All surgeons who were involved in or had expressed interest in the ongoing Prophylactic Antibiotic Regimens in Tumour Surgery (PARITY) trial were invited via email to participate in an in-person focus group to discuss their experiences with collaborative research in orthopaedic oncology. The focus group discussion was digitally recorded, transcribed verbatim and anonymised. The focus group transcript was analysed using qualitative description – an analytic approach which aims to organise the data in the language of the participants with little theoretical interpretation.

The 13 orthopaedic surgeons who participated in the focus group discussion represented orthopaedic oncology practices from seven different countries (Argentina, Brazil, Italy, Spain, Denmark, United States and Canada). Four categories and associated themes emerged from the discussion: (1) the need for collaboration in the field of orthopaedic oncology due to the rare incidence of disease and the need for higher level evidence to guide treatment; (2) motivational factors for participating in collaborative research including establishing proof of principle, learning opportunity, answering a relevant research question and being part of a collaborative research community; (3) barriers to participating in collaborative research including funding, personal barriers, institutional barriers, trial barriers, and administrative barriers; and (4) facilitators for participating in collaborative research including institutional facilitators, leadership, authorship, trial set-up, and Methods Centre support.

Orthopaedic surgeons involved in an ongoing international randomised controlled trial (RCT) were motivated by many factors to participate in the trial and experienced a number of barriers to and facilitators for their participation. There was a collective sense of fatigue experienced in overcoming barriers to participating in collaborative research which was mirrored by a strong collective sense of the importance of, and need for collaborative research in the field of orthopaedic oncology. The experiences were described as essential, educational first steps to move forward collaborative studies in the field. Knowledge gained from this study will inform the development of future large-scale collaborative research in orthopaedic oncology.

### **74. A COMPARISON OF OUTCOME OF TWO TREATMENT PARADIGMS FOR SACRAL CHORDOMA: DOES PRE-OPERATIVE RADIATION IMPROVE PROGNOSIS?**

**Presenter: Matthew T. Houdek, ON**

P. Rose, MN, J. Wunder, ON, F. Sim, MN, P. Ferguson, ON

The mainstay of treatment for sacrococcygeal chordomas is en-bloc excision with wide margins, however this often leads to significant morbidity for patients. Even following complete surgical resection there is purportedly a high risk of local recurrence. As a result, some institutions combine pre-operative radiotherapy with surgical excision in an attempt to reduce the risk of local recurrence in the setting of the close resection margins which are inherent to these procedures. The purpose of this study was to compare cohorts from two large tertiary sarcoma centres in North America (USA and Canada) to determine if the addition of radiation to the treatment protocol for patients with chordoma can improve outcomes.

We identified 112 patients who underwent surgical excision of a sacrococcygeal chordoma at two sarcoma centres. The patients' radiographic and medical records were reviewed for clinical outcomes as well as post-operative complications. There were 39 females and 73 males, with a mean age of 58 years at the time of surgery and a mean follow-up of eight years (range one to 25 years). All patients underwent resection with curative intent. The resection was accomplished through a combined anterior/posterior (n=69) or a solitary posterior (n=43) approach. Negative margins were obtained in 95 patients. The most common cephalad resection level was S2 (n=47). Neoadjuvant radiotherapy was given to 23 patients.

The 10-year disease-free and overall survivals were 50% and 63%, respectively. Patients with a positive surgical resection margin were at significantly increased risk of mortality (HR 2.54, P=0.02) and tumour recurrence (HR 2.70, P=0.03). Tumour size greater than 9cm in maximal dimension was associated with increased risk of local recurrence (HR 1.99, P=0.02). Post-operative complications occurred in 55% of patients; most commonly, wound break down leading to surgical debridement (n=32). Pre-operative radiotherapy did not reduce the risk of mortality (HR 1.42, P=0.45), local recurrence (HR 0.55, P=0.23), or development of distant disease (HR 0.98, P=0.97). However, pre-operative radiotherapy did increase the risk of post-operative wound complications (OR 3.23, P=0.01).

Complete surgical resection was the most important factor in the treatment of sacral chordomas. In this retrospective study, pre-operative radiotherapy did not reduce the risk of mortality, local tumour recurrence or development of metastatic disease. It was however associated with a significantly increased risk of wound complications. Future prospective studies comparing surgical excision with or without pre-operative radiotherapy are needed in order to completely examine its utility in the management of patients with sacral chordomas.

## **75. COMPLICATIONS AND OUTCOMES FOLLOWING FREE FIBULA RECONSTRUCTION FOR SPINAL PELVIC DEFECTS FOLLOWING RESECTION OF A MALIGNANT TUMOUR IN THE AXIAL SKELETON**

**Presenter: Matthew T. Houdek, ON**

K. Bakri, MN, F. Sim, MN, P. Rose, MN, S. Moran, MN

Following tumour resection of the axial skeleton and pelvis, reconstructive surgeons are often left with large composite bone and soft tissue defects in a physiological poor host. Vascularised bone transfer, namely free fibula transfer, can be used in order to supplement stability to the spine and pelvis in the setting of large osseous defects. In the extremities the use of these flaps has been reliable, however, due to the various host factors the use of vascularised bone transfer has associated with a high complication rate in the setting of oncological reconstruction. Currently there is a paucity of data on the use of these flaps in the axial skeleton and pelvis, with historically a high rate of failure without vascularised bone transfer.

We retrospectively reviewed the records of 25 cases of vascularised fibula transfer performed to reconstruct a bony defect following an oncological resection of the spine, sacrum or pelvis from 2000 and 2014. Pertinent demographics as well as information regarding the surgical procedure and disease status at latest follow-up were reviewed. The cohort consisted of 14 males and 11 females; with a mean age at surgery of 38 years (14-68 years) and a mean follow-up of five years (range one to 14 yrs). The most common pathology was osteosarcoma (n=5) and chondrosarcoma (n=5).

The overall two, five, and 10-year survival was 73%, 53%, and 35%. In regards to disease specific survival, the overall two, five, and 10-year survival was 76%, 66% and 44%. Disease recurrence occurred in seven patients (local only, n=2, distant, n=3, local and distant, n=2), leading to death in five patients. Although not

significant, there were no cases of failure when a double rod construct was used compared the four failures where a single rod construct was used ( $P=0.26$ ). The mean time to union was eight months (range 4-13 months) with an overall union rate of 76%. Complications were common following this procedure, with 19 (72%) patients sustaining at least one post-operative complication. Following the procedure the mean MSTS functional score was 16 (range 4-26). Thirteen patients were ambulating following the procedure.

The free-fibula is considered the work horse vascularised bone graft for extremity reconstruction, however data on the use of the vascularised fibula in the axial skeleton and pelvis is limited. The results of this study show the fibula can supplement reconstruction and fusion, with graft union in a majority of patients. Complications were high following the procedure and likely related to the physiological poor host and size and complexity of the surgery. Currently we advocate for the use of a double rod construction, as this could potential reduce rates of failure.

## **76. THE ONCOLOGIC AND FUNCTIONAL OUTCOMES OF ILIOSACRAL RESECTION FOR PRIMARY BONE TUMOURS**

**Presenter: Anthony M. Griffin, ON**

S. Gupta, Scotland, K. Gundle, OR, L. Kafchinski, TX, J. Wunder, ON, P. Ferguson, ON

A type I iliosacral pelvic resection for tumour often creates a large segmental pelvic ring defect, the management of which remains controversial as the surgeon may or may not reconstruct the resultant pelvic defect. When no reconstruction is performed, the residual ilium collapses back onto the remaining sacrum over time thereby creating an iliosacral pseudarthrosis.

The goal of this study was to evaluate the oncologic outcome, complications and functional outcomes of type one pelvic resections with or without reconstruction. Thirty-seven patients who required a type one pelvic resection for tumour with resultant pelvic ring discontinuity between 1989 and 2015 were identified from our prospectively collected database. Local recurrence-free, disease-free and overall survival were assessed using the Kaplan-Meier method. Patient function was assessed using the Musculoskeletal Tumour Society (MSTS) scoring system and the Toronto Extremity Salvage Score (TESS).

The 14 women and 23 men had a median age of 32 years (15-85). The diagnoses were 19 chondrosarcoma, four osteosarcoma, four Ewing sarcoma, five other bone sarcomas and five giant cell tumours. At a mean follow-up of 83 months (1-217), 30 patients were alive without disease, five were dead of disease and two were deceased of other causes. Four patients presented with metastatic disease; there were no local recurrences and five patients developed subsequent metastatic disease. Five-year local recurrence free survival was 100%, Five-year metastasis-free survival was 83.8% and overall survival was 80.2%. Only 4/37 (11%) patients had a reconstruction of the defect. Nineteen patients (51%) experienced at least one complication, including all four patients with reconstructions: 15 wound healing complications/ infections, three fractures and one pulmonary embolism. Most complications were early; Four patients had multiple complications. The mean score for MSTS 87 was 21.1 (+/- 7.8), MSTS 93 was 65.9 (+/-23.8) and TESS was 76.4 (+/-19.3).

Patients requiring type one pelvic resections had a very good oncologic outcome. Complication rates were reasonable and generally acute in nature. Reconstructing the type 1 defect appears to be associated with more frequent complications without improved functional outcome, thereby bringing into question its benefit.

## **77. OUTCOMES FOLLOWING SURGICAL MANAGEMENT OF METASTATIC LONG BONE DISEASE**

**Presenter: Anas Nooh, QC**

K. Goulding, QC, M. Isler, QC, S. Mottard, QC, A. Arteau, QC, N. Dion, QC, R. Turcotte, QC

Bone metastases represent the most frequent cause of cancer-related pain. Although most bony metastatic lesions can be managed non-operatively, surgical management remains the standard of care for patients with severe pain, impending or established pathological fractures. Studies have demonstrated functional improvement post-operatively as early as six weeks, but little data exists on exact timing of these improvements post-

operatively. In this study, we sought to examine: whether patients' functional outcome, pain and quality of life improved following surgery for long bone metastases, the overall and 30-day rate of rate of complications; and the oncologic outcomes including local disease progression.

A multicentre, prospective study was conducted between 2008 and 2016. A total of 187 patients were enrolled in the study, with full post-operative data available for 139 patients. The Musculoskeletal Tumour Society (MSTS) functional score, the Toronto Extremity Salvage Score (TESS), the Brief Pain Inventory (BPI) form, and the Quality Of Life During Serious Illness (QOLLI-P) form were administered pre-operatively and post-operatively at two, six, 12, 26 and 52 weeks. The majority of patients (69.8%) had lower limb lesions while 30.2% had upper limb tumours. Pathological fractures were present in 47 (33.8%) patients. Fifty-four (38.9%) patients were treated with intramedullary nailing, 48 (34.5%) patients underwent endoprosthetic replacement, 31 (22.3%) had plate osteosynthesis, four (2.9%) underwent curettage only, and two (1.4%) were managed with allograft reconstruction. Thirty-seven (26.6%) patients completed the 52-week follow-up. Analysis of variance was conducted to test for significance between pre- and post-operative scores.

MSTS scores demonstrated a statistically significant improvement at two, six, 12, 26 as well as 52 weeks when compared to the preoperative scores ( $P < 0.001$ ). There was no difference in TESS scores at two weeks postoperative compared to pre-operative, however, there was a significant difference at six, 12, 26 and 52 weeks when compared to the preoperative scores ( $P < 0.001$ ). With regard to pain relief, the BPI scores demonstrated a reduction in pain scores at two, six, 12, 26 as well as 52 weeks when compared to the preoperative scores ( $P < 0.001$ ). There was no difference in quality of life as measured by the QOLLI-P score. The overall rate of complications was 33%, with 50 complications reported in 46 patients. The 30-day rate of systemic complications was 13%, with only one early death. Local disease progression occurred in 16 patients (11.5%).

Surgical management of metastatic long bone disease improves patients' functional outcome and pain scores as measured by the MSTS, TESS and BPI scores. These improvements were significant as early as two weeks post-operatively for MSTS and BPI. These results suggest that surgical management is beneficial in patients with metastatic bony disease with expected short-term survival.

## **78. ASSESSING THE NEED FOR MULTIDISCIPLINARY METASTATIC BONE DISEASE CLINIC AT A TERTIARY CANCER CENTRE**

**Presenter: James Lee, ON**

M.A. Sobeai, ON, V. Kansal, ON, J. Werier, ON, H. Abdelbary, ON

A skeletal related event (SRE) is a bone metastasis that can cause pathologic fracture or spinal cord compression and might require radiation therapy, radiologic intervention and/or surgery. Early detection and timely management of SREs is crucial in improving quality of life for patients with metastatic bone disease (MBD). The question of this study is to identify gaps in the care delivered to patients with MBD and assess the need for a multidisciplinary metastatic bone disease clinic to bridge these gaps.

From January 2013 to December 2014, a total of 109 cases of MBD patients who required surgery were identified. A retrospective review of these cases was performed. The following information was extracted from the electronic medical records: primary cancer of bone lesion, age distribution, referral patterns, types of orthopaedic intervention, survival post-surgery, patterns of adjuvant radiotherapy, length of stay in hospital post-surgery.

The most common primary site for MBD was breast followed by lung and prostate (40%, 21%, 9% respectively). In regards to referral patterns, approximately 50% of cases were referred from the emergency department (ED), and a referring source was not identified in 20% of cases. Out of all cases referred from the ED, 61% of patients had a previous known diagnosis of cancer with bone metastasis and 24% had known history of cancer, but without diagnosis of bone metastasis. Approximately 60% of cases presented with a pathologic fracture. In 18%, patients required more than a single operation to control their symptoms and the most common orthopaedic intervention was plating and medullary nailing and then joint prosthesis (35%, 34%, 21% respectively). Over 80% of patients survived over three months post-operatively. Fifty-two percent of cases

required a length of hospital stay greater than 10 days. Increased length of stay correlated with age, lack of radiotherapy as being referred from the ED.

From the data analysis, there was a lack of well defined referral and clinical care pathway for MBD. This lack of standardisation led to significant gaps in care, increased length of hospital stays and delayed identification of patients requiring rapid surgical intervention. The data also indicated that prolonged length of hospital stay correlated with factors such as, lack of standardised radiotherapy protocols and being referred from ED. This clinical data eludes to the important need for a multidisciplinary MBD program to provide rapid access to care and streamline clinical pathway. For patients, such a program will improve their experience by saving anxiety and effort that they otherwise expend in a fragmented health system.

## **79. VENOUS THROMBOEMBOLIC EVENTS IN SARCOMA PATIENTS: RETROSPECTIVE ANALYSIS OF AN INSTITUTIONAL DATABASE**

**Presenter: Krista A. Goulding, QC**

A. Fakeeh, QC, R. Turcotte, QC, T. Alcindor, QC

Venous thromboembolic events (VTE) are a well-known complication of cancers, most notably adenocarcinomas and hematological malignancies. Sarcomas are usually not considered thrombophilic, but little has been published on the incidence and risk factors of VTE in sarcoma patients. The objectives of this study were 1) to determine the incidence of VTE in patients with extremity and axial bone and soft tissue sarcoma (STS), 2) to identify predictive factors for the development of VTE in these patients treated with surgery, radiation or chemotherapy.

A prospectively collected, institutional database identified 72 of 995 consecutive sarcoma patients (49M; 23F) with the diagnosis of at least one VTE by ultrasound or dedicated computed tomography. Mean patient age was 55 years; diagnosis was STS in 51 (71%) and bone sarcoma in 21 (29%). Tumours were located in the lower extremity (63.9%), axial location (15.2%), upper extremity (12.5%) and retroperitoneum (8.3%). Sixteen patients had distant metastases, one had nodal metastases and three had both. The database was also reviewed for presence of vessel compression and existence of predisposing factors (post-operative setting, central venous catheter placement).

Seventy-two of 995 patients developed at least one VTE, with an incidence of 7.23%. Excluding post-operative setting and central venous catheter placement, the number of sarcoma-associated VTEs was 37 (incidence of 3.7%). Despite anticoagulation with high dose low-molecular-weight heparin (LMWH), 14 more cases of recurrent VTE were detected. Factors associated with recurrent or multiple VTE were STS ( $P=0.03$ ) and treatment with surgery and chemotherapy ( $p=0.021$ ). The most common sarcoma subtypes associated with VTE were liposarcoma, osteosarcoma, and leiomyosarcoma. Tumour grade and anatomic location were not apparent risk factors.

Thromboembolic events are infrequent in sarcoma patients and are associated with aggressive disease behavior as well as medical interventions. Given the overall low frequency of VTE in these patients, routine thromboprophylaxis does not appear to be warranted, except in high-risk situations such as surgery.

## **80. THE IMPACT OF 3D PRINTED BONE NEOPLASM MODELS ON SURGICAL EXCISION PLANNING**

**Presenter: Leonid Chepelev, ON**

H. Abdelbary, ON, T. Hodgdon, ON, J. Werier, ON, A. Sheikh, ON, F. Rybicki, ON

To explore the impact of the use of patient specific 3D printed bone neoplasm models on surgical planning for bone neoplasm excision, specifically the nature of the procedure, surgeons' confidence, and patient satisfaction with consent.

A total of 20 consecutive patients with complex pelvic neoplasms were included in the study. Diverse neoplasms were addressed, including metastatic and primary pathologies. CT images with IV contrast were acquired for all patients and reconstructed with isotropic voxels and axial slice thickness of 1.25mm. Resultant

DICOM images were segmented using Materialize software (Leuven, Belgium) to identify neoplasms and to delineate the involved neurovascular structures. Models produced in this segmentation were printed using Objet260 printer (Stratasys, Eden Prairie MN). Two orthopaedic surgeons with no prior knowledge of the patients were then asked to provide a preliminary resection and reconstruction plan using only PACS software and rate their confidence. They were then exposed to a 3D printed model and asked to rate their confidence on a Likert scale after modifying their plan, if necessary. All surgical plans were then computationally converted to resection volumes and digitally compared. Finally, in obtaining informed consent for neoplasm excision, patients were asked to rate their satisfaction with consent before and after exposure to 3D models of their disease, on a Likert scale.

A total of 20 diverse neoplasm models, including metastatic (n=15) and primary (n=5), were successfully fabricated and used in pre-operative planning. Exposure to 3D printed models significantly increased surgeons' confidence in their plans and substantially altered surgical plans in all cases, as identified by volume comparison. Patients exposed to 3D models of their disease reported overall higher satisfaction.

Within the limits of this study, tangible, interactive 3D printed models of bone neoplasms in the context of vital proximal neurovascular structures were demonstrated to have a significant objective and subjective impact on improving surgical planning and patient communication.

## **COA Foot and Ankle**

### **81. ANKLE ARTHROSCOPY FOR DIAGNOSIS AND TREATMENT OF FULL THICKNESS CARTILAGE LESIONS IN THE SETTING OF ANKLE FRACTURE**

**Presenter: Rachael Da Cunha, NY**

M. Drakos, NY, W. Shrairer, NY, S. Karnovsky, NY

Ankle fractures treated with anatomic open reduction and internal fixation (ORIF) can still be associated with poor clinical outcomes. The presence of radiographically occult intra-articular chondral injury is a known entity, however the clinical relevance of this is not well established. The purpose of this study was to evaluate the prevalence of chondral lesions, in particular full thickness talar dome lesions, with concurrent arthroscopy in acute ankle fracture ORIF and determine if there is a correlation with patient and fracture characteristics. In addition, we aimed to evaluate the treatment effect on clinical outcomes to establish the role of concurrent arthroscopy in ankle fracture management and aid in guiding treatment.

A retrospective chart review was conducted from prospectively collected registry data. All patients that underwent an acute ankle fracture ORIF with concurrent arthroscopy were identified. Fracture type by the Lauge-Hansen classification as well as by anatomic location were determined. Charts were reviewed to determine the prevalence and grade of chondral lesions. The treatment performed for each chondral lesion was determined. Clinical outcomes with a minimum of one year follow-up were assessed using the foot and ankle outcome score (FAOS).

One hundred and sixteen consecutive patients undergoing acute ankle fracture ORIF with concurrent arthroscopy were included. A chondral lesion was identified in 78% (90/116). Of those, a Grade IV full thickness talar dome chondral lesion was identified in 52% (47/90). Partial thickness lesions were most commonly treated with a debridement alone whereas full thickness injuries most commonly underwent debridement and microfracture with or without defect filling. Patient age was a significant predictor, with patients less than thirty being less likely to have a chondral injury compared to those age greater than thirty (59% vs. 85%,  $p=0.0063$ ). Fracture type by either the Lauge-Hansen or anatomic classification was not significantly correlated with having a chondral injury ( $p=0.39$  and  $0.34$ ). Of the patients that sustained a dislocation at the time of injury, 100% had a chondral lesion which was statistically significant ( $p=0.030$ ). Patients with complete syndesmosis disruption were more likely to have a chondral lesion, but this did not reach statistical significance.

Arthroscopy performed at the time of acute ankle fracture ORIF is useful in diagnosing chondral injuries which may be underdiagnosed by imaging alone. Chondral lesions, in particular full thickness talar dome chondral

lesions, are common. Increased fracture severity, as indicated by the presence of a dislocation at presentation, or a syndesmotic injury may be more likely to present with a chondral lesion and thus should raise suspicion. Concurrent arthroscopy allows for acute treatment of a chondral lesion and may positively affect clinical outcomes.

## **82. 3D PRINTING OF CALCANEAL FRACTURES: AN ANALYSIS OF INTEROBSERVER RELIABILITY IN USING THE SANDERS CLASSIFICATION SYSTEM**

**Presenter: Chris Small, NL**

A. Furey, NL, M. Bartellas, NL

Calcaneus fractures are the most common tarsal fractures and often lead to chronic pain and disability. These fractures are challenging to describe and outcomes are dependent upon accurate reduction and adequate fixation. The current, accepted classification system has a reasonable reliability and is used to facilitate pre-operative planning. 3D printing is a method of recreating complicated anatomical structures quickly and economically. We set out to recreate 3D models of fractured calcanei in order to test whether these models could be classified as accurately as the CT images themselves.

CT scans of intra-articular calcaneus fractures were chosen at random from the local PACS system and the OR records of staff surgeons. DICOM files are generated by the CT scanner. These files are then converted to .stl files. Osiris and Mesh lab software are used to manipulate the image, removing the other bones. Four models were provided to staff as a preliminary analysis. A copy of the Sanders classification chart was provided. Results were tabulated and assessed using a weighted kappa statistic.

We calculated Fleiss' Kappa at 0.52 (95% CI -0.009 to 1) and a percentage agreement at 0.70 (95% CI 0.149 to 1).

Classification of the printed models showed moderate agreement similar to that found using conventional imaging. Our small sample size creates large confidence intervals. Our goal is to now print 30 models to have reviewed by staff and compare the inter observer reliability to that found using CT images of the same fractures.

## **83. SIMULATED ARTHROSCOPIC HALLUX MT ARTHRODEIS UTILISING FULL THREAD COMPRESSION SCREWS SHOWS SIMILAR STIFFNESS AND LOAD TO FAILURE COMPARED TO LOCKING PATE, WITH LESS PLANTAR GAPPING**

**Presenter: Alastair Younger, BC**

K. Hunt, CO, J. Kelly, CO, R. Fuld, CO, N. Anderson, CO, T. Baldini, CO

To determine the comparative strength and stiffness of an arthroscopic MTP fusion construct compared to standard locked plates. To determine the relationship between each construct and bone density. The first ray of eight matched pairs of fresh-frozen cadaveric feet underwent dissection and DEXA scanning to measure bone mineral density (BMD). The "plate" group was prepared with cup-and-cone reamers, and fixation of the MTP joint with one compression screw and low profile dorsal compression and locked plate. The matched pair "screws" group was prepared through a simulated arthroscopic technique, achieving fixation with two new generation full-thread compression screws, while preserving capsular attachments, to mimic arthroscopic fusion. Each specimen was loaded on the distal phalanx in a cantilever fashion to 90 N at a rate of 3 Hz for a total of 250,000 cycles. Plantar MTP gap was recorded for each cycle using a calibrated extensometer; Load-to-failure testing was performed for all specimens that endured the entire cyclical loading; and stiffness was calculated from the final load-to-failure. Data was analysed with a Student's t-test, with significance set a  $p < .05$ . Pearson Correlation coefficient ( $r$ ) was calculated for stiffness and load to failure vs. BMD.

The plate group demonstrated significantly more plantar gapping during cyclic loading (Figure 1). There was no significant difference in stiffness, 31.6 N/mm (plates) and 51.7 N/mm (screws) ( $p=0.24$ ) or load to failure, 198.6 N (plates) and 290.1 N (screws) ( $p=0.07$ ). During the first loading cycle, none of the locked plate specimens failed, and two of eight screws specimens failed. During cyclic loading, three of eight locked plate specimens



failed, and no screws only specimens failed. Stiffness and load to failure were highly correlated to BMD for both the plate group,  $r=0.85$  and  $r=0.62$ , respectively, and the screws only group,  $r=0.82$  and  $r=0.94$ , respectively. Decrease in strength of the construct with diminished bone density was therefore more relevant for the screw group.

These data demonstrate that arthroscopic fusion of hallux MTP arthrodesis utilising full thread compression screws has less plantar gapping compared to dorsal locking plates, while being similar in mean stiffness and load-to-failure. These results indicate the possibility of an increased role of arthroscopic fusion clinically. Of note, the two preload failures of the screws only cohort occurred in specimens with the lowest BMD, potentially indicating a clinical contraindication with this technique. BMD and metatarsal width may aid in predicting early failure such that appropriate fixation construct and post-operative protocol might improve results for these patients. Screw fixation should likely be avoided in severe osteoporosis, or combined with limited weight-bearing and/or immobilisation.

#### **84. A PROSPECTIVE COHORT-STUDY ON THE RETURN TO WORK AND FUNCTION TWO YEARS AFTER SURGICAL TREATMENT OF TIBIOTALAR ARTHRITIS**

**Presenter: Olivier Gagne, BC**

A. Veljkovic, BC, M. Glazebrook, NS, T. Daniels, ON, M. Penner, BC, K. Wing, BC, P. Dryden, BC, A. Younger, BC

Ankle arthritis is a debilitating condition. People who are affected by end stage ankle arthritis are as symptomatic as arthritis in other main articulations of the lower extremity, and often present with concurrent medical conditions and comorbidities. Once these patients cannot perform their job due to disabling arthritic ankle, they leave the workplace and require financial aid. The purpose of this study was to determine the work status before and after surgery for end stage ankle arthritis in the working age population. We hypothesised that middle-age patients at the time of surgery [55 years-old and younger] were able to go back to work within two years of their index ankle procedure and not depend on social/subsidised programs.

Since 2001, patients treated for end-stage ankle arthritis in three Canadian centres were offered to partake in the Canadian Orthopaedic Foot and Ankle Society (COFAS) Prospective Ankle Reconstruction Database. The modalities of treatment included total ankle replacement and ankle arthrodesis (open and arthroscopic). A survey was given to patients at various points of the study, which included the MODEMS questionnaire from AAOS and SF-36. This study used the pre-operative survey, including the along with the same survey filled by patients two years post-operatively. Degenerative osteoarthritis, post-traumatic osteoarthritis and inflammatory arthritis requiring surgical intervention was the main inclusion criteria. Patients over 55 years old at the time of surgery were excluded.

This group had 211 patients of age  $47\pm 8$  and was balanced as far as sex (113M) and side (102L). The employment rate for this group should be 79.2 per Statistics Canada. The employment rate prior to surgery was 56% and increased to 63% two years later. The additional 7% were on leave of absence or disability prior to surgery. At the two-year follow-up, 92 patients reported less pain with work, 88 patients reported that the surgery met their expectations and 78 reported minimal interference with their work. With regards to WCB, Disability and Social Security, 115 (56%) were never on any of the above, 41 (20%) were no longer on any two years post-operative and 9 (4%) entered at least one program.

The two-year follow-up after tibiotalar arthrodesis or arthroplasty in patients younger than 55 years old shows that more people are able to get back to work than go off work. It also shows that more people are able to get off subsidised programs and that there is an overall satisfaction with regards to pain, inference with work and expectation. After surgery, this patient population still has a lower employment rate than the normal population. More research would be needed to better outline strategies that could reduce the disability within this group and maintain them in the workforce.

## **85. RATES OF ACUTE AND DELAYED ACHILLES TENDON RUPTURE IN BRITISH COLUMBIA AND THE RELATIONSHIP TO THE WILLITS PUBLICATION**

**Presenter: Sam Park, BC**

A. Younger, BC, A. Veljkovic, BC, M. Penner, BC, K. Wing, BC

The findings from a landmark randomised trial in 2010, which showed similar rates of re-rupture following acute repair of Achilles tendon ruptures and non-operative functional rehabilitation, questioning the need for surgical intervention for such injuries. However, some concern has been raised as to the strength of the muscle tendon complex if the Achilles tendon is too long following conservative treatment, potentially increasing the rate of late repair. This retrospective observational study aimed to analyse the rates of acute vs. delayed repair before and after the publication of the 2010 landmark trial.

All patients in our geographical health region who underwent surgical repair of an Achilles tendon rupture between 1997 and 2015 were identified using administrative billing data. Acute repairs were identified as surgery within six weeks of presenting with injury, while delayed repairs were surgical intervention performed after six weeks. The rates of acute and delayed surgery were plotted prior to 2010 and after 2010. The rates of surgical repair were fitted against time using a linear and binomial plot. The rate of surgery for both acute repair and chronic repair were compared using ANOVA prior to and since 2010.

The rate of acute repair in British Columbia increased from 271 repairs in 1997 to over 400 repairs per year in 2008/2009. The rate of acute repair has since dropped to just over 300 repairs per year since 2010. This is reflected in a binomial plot showing a peak and decrease in time. This is also reflected in that there was a significant increase in time prior to 2010 using a person correlation ( $r^2$  0.8,  $p < 0.05$ ). Between 1997 and 2014 the late repair rate has consistently increased in time ( $r^2$  0.8,  $p < 0.001$ ).

The landmark 2010 paper has resulted in a reduction of acute repair. However the increase in late repair is concerning and indicates that the muscle tendon weakness observed in the 2010 paper on strength testing at one year review in the non surgical group may be causing an increased rate of late repair. Further evaluation and development of both surgical and non surgical technique is required if the need for late repair is going to be avoided that likely reflects poor patient outcomes.

### **COA Upper Extremity**

## **86. LATISSIMUS DORSI TRANSFER AUGMENTATION - SUPERIOR OUTCOME IN PATIENTS WITH SUBSCAPULARIS TEAR**

**Presenter: Jennifer Much, QC**

C. Sidler-Maier, ON, M. Sidler, ON, D. Leivadiotou, ON, J. Payandeh, ON, D. Nam, ON

Latissimus dorsi tendon transfer has become an established reconstructive procedure for massive irreparable rotator cuff tears, but has had variable results. As the latissimus dorsi tendon is tenuous, we describe a modified tendon transfer procedure specifically augmented by an acellular dermal allograft to reinforce the native tendon and increase its tensile properties during the harvest, transfer and healing phases.

This retrospective study included 24 patients managed with latissimus dorsi transfer using acellular dermal tissue augmentation between March 2009 and December 2015. The allograft was sutured to the latissimus dorsi tendon as an onlay to the bursal side and was not used as an interposition for tissue loss, such that the host latissimus tendon was in direct contact with the prepared lateral bone trough, the medially retracted tendon stump and the superior fibers of subscapularis if present or tenodesed to the lesser tuberosity in case of absent subscapularis. At the completion of the reconstruction, full superior humeral head coverage was achieved. Outcome measures included the Constant score and the DASH score. The acromio-humeral distance was measured on standardised radiographs.

All 24 patients were men with a mean age of 57 years (range 48 to 70 years). Seven patients had a previously failed rotator cuff repair and 10 patients presented with a deficient subscapularis tendon. At last follow-

up (mean 27 months), all patients but one were satisfied with their outcome and had substantial pain reduction. The unsatisfied patient had a documented re-rupture. Overall, there was significant improvement in active forward flexion (mean increase 31°;  $p=0.016$ ), and abduction by 25° ( $p=0.059$ ). The acromio-humeral distance (ACHD) remained stable. Neither a history of previous rotator cuff surgery nor the presence of a subscapularis tear had an impact on functional outcome. In fact, patients with subscapularis tears showed a greater gain in abduction (mean 43°;  $p=0.075$ ) and had better post-operative Constant Scores ( $p=0.01$ ) than patients without subscapularis tears.

Latissimus dorsi tendon transfer augmented by acellular dermal allograft restored good function and substantially reduced pain with a low failure and complication rate. It was demonstrated to be a reliable procedure for patients with previously failed primary rotator cuff repair and especially in patients with a deficient subscapularis tendon, currently considered a relative contraindication for this procedure.

## **87. TEMPORAL AND REGIONAL TRENDS IN THE MANAGEMENT OF PROXIMAL HUMERUS FRACTURES ACROSS A 13 MILLION PATIENT DATABASE**

**Presenter: Lauren Nowak, ON**

M. Bonyun, ON, A. Nauth, ON, M. Mckee, ON, E. Schemitsch, ON

The treatment of proximal humerus fractures remains controversial due to a lack of conclusive evidence supporting any specific treatment type. To date, no study has evaluated temporal and regional patterns of treating proximal humerus fractures in Canada. The purpose of this study was to utilise administrative data to characterise proximal humerus fracture treatment patterns and outcomes in older adults over time, and across geographic regions of a 13 million population database of Canadians.

We collaborated with the Institute for Clinical Evaluative Sciences to evaluate coded and linkable health datasets for this study. We identified all patients 50 years and older who presented to an emergency room with a "main diagnosis" of proximal humerus fracture from April 1, 2004 to March 31, 2013. We used a combination of intervention and fee codes to place patients into replacement, fixation, closed reduction with no fixation, or non-operatively treated groups, and identify those who returned for a complication-related operation within two years of the index fracture. We assessed geographic variation using Local Health Integration Networks (LHINS); health authorities responsible for the regional administration of public healthcare services.

We identified 32,760 patients with proximal humerus fractures from April 1, 2004 to March 31, 2013. Across LHINS, the proportion of patients in each treatment group varied significantly ( $p<0.05$ ). Patients receiving joint replacement ranged from 3.3% (95%CI 2.4-4.5%) to 6.5% (95%CI 5.5-7.8%) while fixation rates ranged from 5.0% (95%CI 4.1-6.1%) to 11.9% (95%CI 10.9-12.9%). The rate of closed reduction procedures ranged from 3.4% (95%CI 2.8-4.5%) to 13.7% (95%CI 12.0-15.3%) and non-operative treatment rates ranged from 71.8% (95%CI 69.6-73.9%) to 83.1% (95% CI 81.7-84.4%). The rate of complication-related operations within two years of initial treatment also varied significantly across LHIN's for patients in the fixation and non-operative groups. Of the patients treated initially via fixation, the proportion of patients returning to the operating room within two years ranged from 21.2% (95%CI 16.8-26.4%) to 35.2% (95%CI 28.6-42.5),  $p = 0.005$ . Of those treated non-operatively, the proportion with a complication-related operation within two years of the initial fracture ranged from 1.1% (95%CI to 0.7 - 1.8%) to 3.4% (2.7 - 4.6%),  $p<0.001$ .

Despite uncertainty surrounding the value of surgery, the rate of operative treatment of proximal humerus fractures in this population has remained relatively constant from 2004 to 2013. We found significant variation in treatment patterns across regional health authorities, which could potentially suggest over- or under- use of surgery in some areas. We also found significant variation in patient outcomes across regional health authorities. This study provides a basis for further evaluation into why we are observing such variation, and examining potential sources.

## **88. THIRTY AND NINETY-DAY READMISSION FOLLOWING TOTAL SHOULDER ARTHROPLASTY: A POPULATION-BASED ANALYSIS OF RATE, RISK AND REASON FOR READMISSION**

**Presenter: Timothy Leroux, ON**

B. Basques, IL, R. Frank, IL, R. Thorsness, IL, N. Verma, IL, A. Romeo, IL, J. Griffin, VA

Health care payers are increasingly evaluating reimbursement based on quality measures. Recent initiatives to improve hospital quality of care include critically assessing unplanned hospital readmission rates. The purpose of this study was to evaluate readmission rates and risk factors for readmission after total shoulder arthroplasty (TSA) in order to identify patient factors and medical comorbidities that may variably impact rates of readmission.

Using Current Procedural Terminology (CPT) and International Classification of Diseases, 9th Revision (ICD-9) procedure codes, we queried a national Medicare database for patients undergoing TSA between 2005 and 2012. Patients were divided into various cohorts utilising ICD-9 codes and other comorbidities and analysed accordingly. Readmission rates were assessed with ICD-9 and CPT codes. Patient characteristics were compared between procedure groups with chi-squared analysis. Multivariate logistic regression was used to compare groups in terms of post-operative complications within 90 days, and readmission within 30 and 90-days. Multivariate regression controlled for differences in baseline patient characteristics.

A total of 103,345 Medicare patients underwent TSA and were identified from 2005 to 2012. 1,012 patients (1.3%) were readmitted within 30 days and 3,516 (3.4%) were readmitted within 90 days following TSA. Thirty-day readmission occurred more commonly in obese patients as well as those with diabetes (20%), chronic obstructive pulmonary disease (COPD) (18%), coronary artery disease (CAD)(19%), and chronic kidney disease (CKD) (4.7%) (p

There was a significant increase in readmission rates within 30 and 90 days in patients over the age of 80. The odds of post-operative readmission after TSA within 30 or 90 days was significantly greater in patients with COPD, CKD, CAD, obesity and smokers. Major and minor medical problems, dislocation, and infection make up some of the most common reasons for readmission after TSA. These results may have important implications in terms of surgical decision-making, outpatient arthroplasty, patient counselling, and quality control measures.

## **89. SUBSCAPULARIS REPAIR IS UNNECESSARY AFTER LATERALISED REVERSE SHOULDER ARTHROPLASTY**

**Presenter: Richard J. Hawkins, SC**

M. Kissenberth, SC, E. Shanley, SC, S. Tolan, SC, K. Lonergan, SC, T. Roberson, SC, J. Griscom, SC, Q. Hunt, SC, C. Granade, SC, K. Adams, SC, J. Tokish, SC

Reverse shoulder arthroplasty has become a valuable approach to patients with shoulder arthropathy and a deficient rotator cuff. Design characteristics and technical aspects in this procedure continue to be refined. One such technical controversy is whether to repair the subscapularis after reverse shoulder arthroplasty. In the setting of a Grammont-style medialised prosthesis, repair has become controversial with some studies demonstrating that post-operative subscapularis deficiency is associated with higher complication rates such as instability. Few studies have evaluated functional outcomes after reverse shoulder arthroplasty stratified by repair vs. non repair of the subscapularis, and no study has evaluated this question in the setting of a lateralised prosthetic design. The purpose of this study was to evaluate the effect of repairing the subscapularis after reverse total shoulder arthroplasty with regard to complications, objective findings, and patient reported validated outcomes measures.

One hundred twenty four patients who had undergone reverse shoulder arthroplasty by one of four fellowship trained shoulder surgeons were retrospectively reviewed. All patients underwent a reverse shoulder arthroplasty with a lateralised design. Fifty-five patients had subscapularis repair at the conclusion of the index case, while 69 did not. Patients in each group were compared with a SANE, PENN, and ASES score at a minimum of two year follow-up. Data on demographics, range of motion, and complications were also compared. A one-way ANOVA was performed to determine the difference in performance and outcome scores based on

repair status of the subscapularis. A chi-square analysis was performed to compare the frequency of complications between groups.

Patients who underwent subscapularis repair demonstrated a maximum of an eight point difference in PENN (mean 68) , SANE (mean 70), and ASES (mean 69) scores, which was not statistically significant. Significantly younger patients received a subscapularis repair as compared to older patients ( $67.3 \pm 7.6$  vs.  $70.4 \pm 7.6$ ;  $p=0.02$ ). Patients were similar in gender ( $p=0.36$ ) and comorbidities ( $p=0.6$ ). Post-operative ROM was similar for forward elevation ( $127.1 \pm 30.1$  vs.  $119.3 \pm 31.7$ ;  $p=0.15$ ) and external rotation ( $31.7 \pm 15.2$  vs.  $28.8 \pm 12.1$ ;  $p=0.29$ ) when comparing patients with a subscapularis repair to those without repair. Ten percent of patients in the repair group experienced a complication, which was not significantly different from patients who did not undergo repair (5%) ( $p=0.51$ ).

Repair of the subscapularis is unnecessary in patients undergoing reverse shoulder arthroplasty with a lateralised design. Patients who undergo repair demonstrate similar patient reported outcomes, range of motion, and complication rates. We no longer recommend repair of the subscapularis in this setting.

## **90. OUTPATIENT TOTAL SHOULDER ARTHROPLASTY: A POPULATION-BASED STUDY COMPARING ADVERSE EVENT AND READMISSION RATES TO INPATIENT TOTAL SHOULDER ARTHROPLASTY**

**Presenter: Timothy Leroux, QC**

B. Basques, IL, R. Frank, IL, J. Griffin, VA, G. Nicholson, IL, B. Cole, IL, A. Romeo, IL, N. Verma, IL

The rate of total shoulder arthroplasty (TSA) is rising, which impacts health care expenditure. One avenue to mitigate cost is outpatient TSA. There are currently no published reports of this practice. In this study, we determine the 30-day adverse event and readmission rates following outpatient TSA, and compare these rates to inpatient TSA.

A retrospective cohort study using a population database in the United States was undertaken. Patients who underwent primary TSA between 2005 and 2014 were identified and divided into two cohorts based upon length of stay (LOS): outpatient TSA (LOS 0 days) and inpatient TSA (LOS >0 days). Patient and procedure characteristics were collected. The 30-day adverse event and readmission rates were calculated for each cohort. A multivariate logistic regression determined if the odds of an adverse event or readmission were significantly different between the inpatient and outpatient TSA cohorts.

Overall, 7,197 patients underwent TSA between 2005 and 2014, of which 173 patients (2.4%) underwent outpatient TSA. The 30-day adverse event rate in the outpatient and inpatient TSA cohorts was 2.31% and 7.89%, respectively. The 30-day readmission rate in the outpatient and inpatient TSA cohorts was 1.74% and 2.93%, respectively. In the multivariate logistic regression, the odds of an adverse event or readmission were not significantly different (OR 0.4 [ $p=0.077$ ] and OR 0.7 [ $p=0.623$ ], respectively).

There are no significant differences in the 30-day adverse event and readmission rate between outpatient and inpatient TSA. In the appropriately selected patient, outpatient TSA is safe and cost-effective.

## **91. COMPARISON OF SUBSCAPULARIS TENOTOMY TO SUBSCAPULARIS PEEL IN SHOULDER ARTHROPLASTY: A PROSPECTIVE, RANDOMISED, CONTROLLED TRIAL**

**Presenter: Peter Lapner, ON**

A. Sheikh, ON, T. Zhang, ON, G. Athwal, ON

Controversy exists regarding the optimal technique of subscapularis tendon mobilisation during shoulder arthroplasty. The purpose of this randomised double-blind study was to compare subscapularis strength and functional outcomes between the subscapularis tenotomy and subscapularis peel during shoulder arthroplasty.

Patients undergoing total shoulder arthroplasty were randomised to receive either a subscapularis tenotomy or a subscapularis peel. The primary outcome was subscapularis strength, as measured by an electronic hand-held dynamometer at 12 months post-operatively. Secondary outcomes included the WOOS and ASES scores.

Forty-six patients were allocated to subscapularis tenotomy, and 51 patients to subscapularis peel. Seventy-four percent of the study cohort returned for the 12 months follow-up. The primary outcome of subscapularis strength at 12 months follow-up revealed no significant difference ( $p=0.43$ ) between the tenotomy (4.1 kg, SD 3.2) and the subscapularis peel (4.7 kg, SD 2.3). Comparison of secondary outcomes including the WOOS, and ASES scores demonstrated no significant differences between groups at any time point. Compared to baseline measures, mean subscapularis strength, WOOS, and ASES scores all improved significantly in both groups at 12 months follow-up ( $p<0.001$ ).

No statistically significant differences in the primary or secondary outcomes of function were identified between the subscapularis tenotomy and subscapularis peel. For the parameters investigated, this trial does not demonstrate any clear advantage of one subscapularis management technique over the other.

## **92. COMPARING SURGICAL REPAIR TO CONSERVATIVE TREATMENT AND SUBACROMIAL DECOMPRESSION ALONE FOR THE TREATMENT OF ROTATOR CUFF TEARS: A META-ANALYSIS OF RANDOMISED TRIALS**

**Presenter: Christine Schemitsch, ON**

J. Chahal, ON, M. Vicente, ON, P-H. Flurin, France, F.L. Heerspink, Netherlands, P. Henry, ON, A. Nauth, ON

Degenerative rotator cuff tears are a common cause of dysfunction in patients aged 60 years or older. While it is generally agreed upon that acute, traumatic tears in young patients should be managed with surgical repair, the optimal treatment for managing symptomatic chronic/degenerative tears in these patients remains controversial. The purpose of this study was to compare the effectiveness of surgical repair to conservative treatment and subacromial decompression for the treatment of rotator cuff tears in this population by performing a meta-analysis of randomised trials in the literature.

Pubmed, Cochrane database and Medline were searched for randomised controlled trials published until August 2015. Included studies were assessed for methodologic quality (using the Detsky scale) and data were extracted for statistical analysis.

The results of the search yielded 2,537 studies. Five studies were included in this review. Two of the studies directly compared surgical repair to conservative treatment. Two of the studies directly compared surgical repair to subacromial decompression alone. One study compared surgical repair to conservative treatment and subacromial decompression alone in three separate groups. A meta-analysis of the Constant Murley Score (CMS) one year following intervention demonstrated that surgical repair resulted in significantly improved scores compared with conservative treatment (mean difference, 7.58; 95% CI, 3.08 to 12.08;  $P=0.0010$ ). A meta-analysis of the CMS one year following intervention also showed that surgical repair yielded significantly improved scores as compared to subacromial decompression (mean difference, 5.3; 95% CI, 1.77 to 8.85;  $P=0.003$ ). In the conservatively treated group, 11.9% of patients eventually crossed over to surgical repair following unsatisfactory results.

This meta-analysis demonstrates that surgical repair of rotator cuff tears provides significantly improved outcomes when compared to conservative treatment or subacromial decompression alone. The mean difference in the CMS between surgical repair and conservative treatment approached the minimum clinically important difference previously reported in the literature. On the basis of this review, it is likely that rotator cuff repair results in a significant and clinically important improvement in outcomes, although conservative treatment may be appropriate in some patients given the magnitude of the effect of surgery and the “success rate” of conservative treatment.

## **93 – PRE-OPERATIVE NARCOTIC USE AMONG PATIENTS UNDERGOING TOTAL SHOULDER ARTHROPLASTY: AN ANALYSIS OF TRENDS AND INFLUENCE ON POST-OPERATIVE LENGTH OF STAY, COMPLICATIONS, AND READMISSION**

**Presenter: Timothy Leroux, ON**

B. Basques, IL; J. Griffin, VA; R. Frank, IL; N. Verma, IL; A. Romeo, IL

Despite evidence to suggest that pre-operative narcotic use is increasing and negatively influences post-operative outcomes following lower extremity arthroplasty and spine surgery, there exists a paucity of data pertaining to the rates of pre-operative narcotic use and their influence on post-operative outcomes among patients undergoing primary total shoulder arthroplasty (TSA). In the present study, we used a large population database of patients in the United States (US) to 1) determine the annual rate of patients undergoing primary TSA with a history of pre-operative narcotic use in the 90 days preceding TSA, and 2) compare post-operative hospital length of stay, 90-day complication rates, and 30- and 90-day readmission rates between patients undergoing primary TSA with and without a history of pre-operative narcotic use in the 90 days preceding TSA.

A retrospective analysis of private payer data was performed to identify patients undergoing primary TSA in the US between 2007 and 2014. Patients were stratified into two groups based upon a history of pre-operative narcotic use in the 90 days preceding the index TSA procedure, as determined by using the private payer claims database. The rate of patients undergoing primary TSA with a history of pre-operative narcotic use was determined annually from 2007 to 2014. A multivariate logistic regression was used to compare the two groups in terms of length of stay, complications within 90 days (overall and complication-specific rates), and readmission within 30 and 90 days. The multivariate regression controlled for differences in baseline patient characteristics (age, sex, comorbidities, and smoking history), and results were reported as odds ratios (OR) with alpha set at 0.05.

Overall, we identified 11,030 patients undergoing primary TSA between 2007 and 2014, of which 2,424 (22.0%) had a history of pre-operative narcotic use in the 90 days preceding the index TSA. Patients with a history of pre-operative narcotic use were significantly younger ( $p < 0.001$ ), female ( $p < 0.001$ ), smokers ( $p < 0.001$ ), and had higher rates of common comorbidities (diabetes [ $p = 0.02$ ], chronic obstructive pulmonary disease [ $p < 0.001$ ], congestive heart failure [ $p < 0.001$ ], chronic kidney disease [ $p = 0.003$ ]). Over the seven year period, there was no significant increase in the proportion of patients undergoing primary TSA with a history of pre-operative narcotic use (2007: 18.7% vs. 2014: 19.7%,  $p = 0.06$ ). Following primary TSA, there were no significant differences in length of stay ( $p = 0.58$ ) or 90-day complication rates ( $p > 0.05$ ) between patients with and without a history of pre-operative narcotic use. Patients with a history of pre-operative narcotic use were at increased odds of readmission within 90 days of the index TSA (9.2% vs. 7.4%, OR 1.2,  $p = 0.009$ ), but not 30 days (OR 1.2,  $p = 0.09$ ).

In spite of evidence in the orthopaedic literature to suggest that pre-operative narcotic use is increasing and can adversely impact outcomes, we did not find that a history of narcotic use within 90 days of a primary TSA had any significant impact on length of stay or complications, nor has there been a change in the use of pre-operative narcotics over time. Although we observed the 90-day readmission rates was significantly higher among patients with a history of pre-operative narcotic use, the clinical significance of this difference remains in question.

## **Adult Reconstruction Hip 2**

### **2017 Anica Bitenc Fellow**

#### **MODIFIED LATERAL APPROACH IN PATIENTS WITH SEVERE HIP DYSPLASIA UNDERGOING THA**

**Presenter: Ivan Bohacek Croatia**

Goran Bicanic' Croatia, Ana Aljinovic' Croatia Domagoj Delimar, Croatia

We present a modification of the direct lateral approach to the hip, which provides excellent exposure to both, femur and acetabulum. This approach allows adequate shortening of the proximal femur and further leg length equalization in dysplastic hip without necessity for any accessory procedure, such as trochanteric osteotomies, transverse cuts or detachment of abductor muscles.

Two groups of patients with dysplastic hips were compared: a) test group - Crowe 3 and 4 patients, which underwent THA using modified lateral approach; and b) control group - Crowe 1 and 2 patients which underwent THA using direct lateral approach. ROM, strength and balance board testing together with general functional assessment scores were examined before surgery and 6 months after surgery.

ROM, strength and balance board testing were significantly improved postoperatively in both, test and control groups. There was no significant difference between the groups, except in some specific (combined) motions: reduced flexion and internal rotation in test group; and reduced extension, abduction, and external rotation in control group. General functional assessment scores demonstrated significant improvement after surgery in both groups, while, more importantly, there was no significant difference between groups.

We may conclude that the use of modified lateral approach in patients with Crowe 3 and 4 dysplastic hips allows equal functional result compared to Crowe 1 and 2 patients who underwent same procedure with use of standard direct lateral approach. Therefore, we recommend the use of modified lateral approach in patients with severe hip dysplasia undergoing THA.

#### **94. HOSPITAL MORTALITY AFTER HIP FRACTURE SURGERY IN RELATION TO LENGTH OF STAY BY CARE DELIVERY FACTORS**

**Presenter: Boris Sobolev, BC**

P. Guy, BC, K. Sheehan, BC, The Canadian Collaborative Study on Hip Fractures, BC

Two hypotheses were offered for the effect of shorter hospital stays on mortality after hip fracture surgery: worsening the quality of care and shifting death occurrence to post-acute settings. We tested whether the risk of hospital death after hip fracture surgery differed across years when post-operative stays shortened, and whether care factors moderated the association.

We conducted an analysis of acute hospital discharge abstracts for subgroups defined by hospital type, bed capacity, surgical volume, and admission time for 153,917 patients 65 years or older surgically-treated for first hip fracture. The outcome measure was risk of hospital death.

We found a decrease in the 30-day risk of hospital death from 7.0% (95%CI: 6.6-7.5) in 2004 to 5.4% (95%CI: 5.0-5.7) in 2012, with an adjusted odds ratio [OR] 0.73 (95%CI: 0.65-0.82). In subgroup analysis, only large community hospitals showed the reduction of ORs by calendar year. No trend was observed in teaching and medium community hospitals. By 2012, the risk of death in large higher-volume community hospitals was 35% lower for weekend admissions, OR = 0.65 (95%CI: 0.45-0.92) and 39% lower for weekday admissions, OR = 0.61 (95%CI: 0.41-0.92), compared to 2004. In large lower-volume community hospitals, the 2012 risk was 56% lower for weekend admissions, OR = 0.44 (95%CI: 0.26-0.76), compared to 2004.

The risk of hospital death after hip fracture surgery decreased only in large community hospitals, despite universal shortening of hospital stays. This supports the concern of worsening the quality of hip fracture care due to shorter stays.

#### **95. IS VITAMIN D ASSOCIATED WITH IMPROVED PHYSICAL FUNCTION AND REDUCED RE-OPERATION RATES IN ELDERLY PATIENTS WITH FEMORAL NECK FRACTURE TREATED WITH INTERNAL FIXATION?**

**Presenter: Nathan O'Hara, BC**

G. Slobogean, MD, E. Bogoch, ON, B. Petrisor, ON, A. Garibaldi, M. Bhandari, ON, Sheila Sprague, ON, FAITH Investigators, ON

Daily vitamin D supplementation is recommended for individuals over the age of 50, as vitamin D is necessary for general bone health. There has been increased interest within the orthopaedic community on the potential for vitamin D to improve outcomes in fracture patients. The recently completed FAITH trial (cancellous screws vs. sliding hips screws in femoral neck fracture patients over the age of 50 (NCT01908751)) provides a unique opportunity to investigate this further. The objectives of this study are: 1) to determine the proportion of patients who consistently take vitamin D following their fracture and 2) to determine if vitamin D supplementation is associated with improved post-injury physical function and reduces rates of re-operation within two years of the fracture.

The FAITH trial is a multicentre randomised controlled trial of 1,111 femoral neck fracture patients treated with cancellous screws or sliding hip screws. A subset of 625 patients included within this study were asked about



vitamin D supplementation at each of the follow-up visits over a two-year period. Based on their frequency of vitamin D supplementation in the first six-months of follow-up, patients were categorised as either consistent (three to four visits), inconsistent (one to two visits), or non-compliant in their vitamin D supplementation. Patients with one or fewer follow-up visits in the first six-months were excluded from the analysis. Multivariate regression was used to compare the effect of vitamin D supplementation on physical function (defined as the physical component score of the Short Form-12 (SF-12)) at 12-months post-fracture and re-operation, adjusting for baseline SF-12 score, gender, and fracture displacement.

Five hundred and seventy-five patients were included in the final analysis. The mean age was 74.5, the majority were female (65.8%), and had undisplaced fractures (72.6%). 18.7% reported never taking vitamin D, 35.6% reported taking vitamin D inconsistently, and 45.7% reported taking vitamin D consistently. Our adjusted analysis found that consistent vitamin D supplementation post-fracture was associated with a 2.29 increase in the physical component of the 12-month SF-12 score ( $p=0.045$ ). Vitamin D supplementation was not associated with re-operation rates.

Despite highly publicised vitamin D supplementation guidelines we found that a surprisingly low proportion of elderly hip fracture patients are consistently taking vitamin D, which suggests a need for additional strategies to promote compliance with vitamin D supplementation in this population. Our research also found that vitamin D may be associated with improved physical function following a hip fracture. Further research is needed to confirm these findings given the observational nature of this study.

## **96. OUTCOME OF REVISION HIP ARTHROPLASTY FOR INSTABILITY: RISK FACTORS FOR FAILURE AND RE-OPERATION**

**Presenter: Donald S. Garbuz, BC**

A. Herman, Isreal, B. Masri, BC, N. Greidanus, BC, C. Duncan, BC

Instability after total hip replacement (THR) is a common complication with a rate of 0.3% to 5% and 28% after primary or revision total hip replacement, respectively. Several surgical options are available to treat recurrent dislocation after total hip replacement; however, few comparative studies report on these revision outcomes and failures while controlling for other potential confounders such as patient demographics and case-mix. The purpose of this study was to evaluate outcome of revision THR for instability and to specifically evaluate for risk factors associated with failure and re-operation.

A review of our institutional arthroplasty database identified 402 revision THR procedures performed for recurrent instability prior to December 31st, 2013, with a minimum of two years of follow-up, or who were deceased more than one year after surgery. Failure was defined as an aseptic re-revision of the hip or recurrent dislocation. Multivariate proportional hazard model was constructed by model selection using the Akaike Information Criteria (AIC) including patient specific factors, implant specific factors, and other known predictors of THR instability. Results are reported as hazard ratio (HR) and its 95% confidence interval (95% CI).

The analysis included 379 operations, of these 88 (23.2%) had aseptic revision or recurrent dislocation. Of the 88 failures identified: 66 (75.0%) failures were re-revisions due to dislocation, 10 (11.4%) due to dislocation with no re-revision surgery, five (5.7%) due to aseptic loosening of components, five (5.7) due to osteolysis, three (3.4%) due to pseudotumour and one (1.1) due to periprosthetic fracture. Multivariate analysis identified the following factors as significant for increased risk of failure; the use of fully constrained liner (HR=1.84, 95% CI=1.04-3.26,  $p=0.034$ ), augmented liners (lipped, oblique and high offset liners; HR=1.89, 95% CI=1.15-3.08,  $p=0.010$ ), periprosthetic fracture of the femur (HR=2.88, 95%CI=1.39-5.97,  $p=0.004$ ), age over 65 (HR=0.63, 95%CI=0.40-0.98,  $p=0.041$ ), and pelvic discontinuity requiring the use of a cage (HR=3.32, 95%CI=1.49-7.37,  $p=0.003$ ). In patients with abductor dysfunction the use of a focal constrained liners was found to decrease the risk of failure (HR=0.15, 95%CI=0.020-1.11,  $p=0.064$ ). The use of dual mobility or tripolar liners was not found to make a statistically significant difference.

Our comprehensive multivariate analysis suggests that there are specific and significant risks for failure following revision THR for instability. These risks include patient age, associated bone and soft tissue

defects/pathology, characteristics of liner/bearing or constraint selected. In surgical treatment for recurrent dislocation of the hip, it has been shown that fully circumference and augmented liners (lipped, oblique or high offset liners) are associated with the highest failure rates. Focal constrained liners might offer a good alternative for abductor deficient patients.

### **97. HIGH PERIPROSTHETIC FRACTURE RATE ASSOCIATED WITH USE OF UNCEMENTED TAPERED WEDGE STEMS IN FEMORAL NECK FRACTURES**

**Presenter: Jin Soo Andy Song, NS**

D. Dillman, NS, D. Wilson, NS, M. Dunbar, NS, G. Richardson, NS

Hemiarthroplasty is the most common treatment for displaced femoral neck fractures in elderly patients. Previous literature has shown a higher rate of periprosthetic fracture (PF) and re-operation in uncemented stems than cemented stems. Yet there is reluctance for widespread adoption of cementation in the frail elderly due to the potential of intra-operative cardiopulmonary complications. Although there is a lack of literature evaluating the safety of short tapered wedge (TW) cementless stems, there is an increase in use at our institution. The goal of this study is to evaluate the rate of PF, re-operation, and all-cause mortality between cemented and uncemented femoral stem designs in hip fracture patients.

This is an IRB approved retrospective chart review of all patients who received hemiarthroplasty for hip fractures from 2010-2016. Patient outcomes included all-cause mortality, all PF (including intra-operative), all cause re-operation and re-operation due to PF within one year of index surgery. Patient variables including age, gender, ASA and Dorr classification were obtained from electronic medical records to elucidate any correlation with surgical outcomes. The uncemented group was further subdivided into TW stems (a broach only system), traditional uncemented stems (all designs requiring reaming of femoral canal) and Austin Moore (AM) stems. Results were compared using Chi-Square tests.

We included 709 patients in total, with 346 and 363 patients in the uncemented and cemented stem groups respectively. In the uncemented group there were 197 TW, 97 traditional uncemented and 52 AM stems. PF rates were 36 (10.34%) and 14 (3.88%) in the uncemented and cemented groups ( $p=0.001$ ) respectively, resulting in 10 (2.87%) and two (0.55%) re-operations for PF ( $p=0.017$ ). There were six fractures requiring re-operation in the TW stems (3.0%), three in the traditional uncemented stems (3.1%), one in an AM (1.9%) and two in the cemented stem group (0.55%). There was a significantly higher rate of PF in the TW stems than the cemented group ( $p=0.026$ ). There were no significant differences in PF between cemented and all other uncemented stem types ( $p>0.05$ ). For re-operations due to any cause, there were 14 (4.02%) and five cases (1.39%) for cemented and uncemented stems respectively ( $p=0.030$ ). There were 46 (13.21%) and 42 (11.63%) deaths in the uncemented and cemented groups respectively ( $p=0.522$ ).

Uncemented TW stems have a higher rate of re-operation due to PF compared to cemented stems, and a similar rate of re-operation for PF as the traditional uncemented designs. There was no statistically significant difference in all-cause mortality between the uncemented and cemented femoral stem groups. Given the high rate of re-operation in uncemented TW stems, the results of this study support historical literature advocating for use of cemented femoral stems in the hip fracture population.

### **98. AN EARLY REPORT OF THE USE OF A MODULAR DUAL MOBILITY ARTICULATION SYSTEM IN REVISION ACETABULAR RECONSTRUCTION**

**Presenter: Owen Diamond, BC**

S. Konan, UK, N. Greidanus, BC, D. Garbuz, BC, B. Masri, BC, C. Duncan, BC

Instability remains one of the main problems following revision hip surgery. The modular dual mobility (MDM) articulation has recently been introduced in North America for clinical use. The attractions of the MDM include the ability to initially use screw fixation for the shell in the challenging revision acetabulum and then the dual mobility articulation confers increased stability, without the restriction of intra-prosthetic impingement or risk of aseptic

loosening with a constrained liner. The aim of this study was to review the clinical, radiological and patient reported outcomes with the use of modular dual mobility articulation for revision acetabular reconstruction. We also investigated if the modular acetabular components of the dual mobility articulation increase the risk of fretting corrosion by measuring serum trace metal ion levels in a subset of these patients given recent concerns identified in a series of MDM cups used in primary total hips.

Institutional Review Board approved this retrospective cohort study. The Adult Reconstruction Database identified sixty-three consecutive patients as having a minimum 24 months follow-up after insertion of an MDM at the time of revision hip surgery. Patients had an MDM cup inserted because either they were having a revision because of recurrent instability or they were felt to be at increased risk of dislocation at the time of their revision surgery. All patients were contacted via mail or telephone to complete functional outcome scores (WOMAC, SF12, Oxford Hip Score, Satisfaction Scale and UCLA scores), clinic notes and x-rays were reviewed. A subset of patients were invited to have metal ion (Cobalt and Chromium) levels checked.

At most recent follow-up three patients had died, three patients have been revised because of on-going instability and three patients have had revision surgery due to infection. One patient has symptomatic subluxation of the hip but does not want surgery. One patient has impingement with apparent notching on the femoral neck. Overall functional outcome (mean WOMAC function 76, UCLA 5.6, mean Oxford 74.7, SF-12 physical 41.6 / mental 53.3 ) and overall pain relief (mean WOMAC pain score 78.3) were good. The mean satisfaction score was 78 out of 100. The median serum trace metal chromium and cobalt levels at most recent follow-up was 0.3 µg/L (range 0.1 to 6.1 µg/L) and 0.47 µg/L (range 0.21 to 9.42 µg/L) respectively. The survival with revision for instability as the end point was 95.2% at two years.

MDM cups represent an excellent option for the patient having revision hip surgery in the setting of recurrent instability or fear of instability, such as in the case of abductor insufficiency. This series presents good patient reported outcome measures and a low complication and revision rate.

## **99. LONG-TERM FOLLOW-UP OF A SECOND GENERATION METAL-ON-METAL TOTAL HIP ARTHROPLASTY**

**Presenter: Muhammad Albeshar, QC**

N. Stavropoulos, O. Huk, QC, L. Epure, QC, D. Zukor, QC, J. Antoniou, QC

The Metasul (Sulzer, Basel, Switzerland) articular MM interface was one of the second-generation MM THA that was introduced as a promising interface with improved manufacturing technology, better clearances and enhanced metal hardness. In December 2001, the manufacturer recalled these implants due to the failure of cup osseointegration. Cup failure was due to residual machining oil contaminant that prevented cup-bone osseointegration and led to early cup loosening and failure. This study reports our long-term results (minimum follow-up of 15 years) in a cohort of patients that received the Metasul bearing.

Between July 1997 and August 2001, 105 consecutive primary Metasul MM THAs were performed in 94 patients (57 males and 37 females). All patients were implanted with a cementless titanium femoral and acetabular porous-coated component and a 28mm cobalt/chrome femoral head. The mean age of patients at time of surgery was 50 (range: 17-65) years. Cobalt (Co) and chromium (Cr) levels were measured by inductively coupled plasma-mass spectrometry (ICP-MS). The cup inclination and anteversion was measured by Einzel-Bild-Roentgen-Analyse (EBRA) software (University of Innsbruck, Austria) on the radiographs at the last follow-up visit.

At a minimum follow-up of 15 (range 15-18) years, the mean Harris Hip Score and UCLA scores for the surviving THAs were 88.9 and 6.3, respectively. Fourteen THAs were revised at a mean period of 2.5 years (range: 0.1-12.5 years). Eleven of the revised hips were due to failure of osseointegration of the recalled acetabular component. One patient required revision for an undersized stem, one patient required irrigation, debridement and liner exchange for early post-operative infection and one patient was revised for pseudotumour. When excluding contamination from manufacturing defects and infections, the survivorship of the bearing in this cohort at a minimum of 15 years is 97.5%. At the last follow-up, the median Co and Cr level in the whole blood

were 1.24 and 0.83 µg/L, respectively. Only three patients presented increased level of Co and Cr (> 7 µg/L). The acetabular component was placed at an average inclination of  $42.23^\circ \pm 6.1$  (from  $26^\circ$  to  $63^\circ$ ) with an average angle of anterversion of  $16.99^\circ \pm 6.2$  (from  $3.3^\circ$  to  $20.3^\circ$ ).

Excluding the recalled components, Metasul articular interface has performed extremely well at a minimum follow-up of 15 years in this relatively young and active patient population. There was a revision for one pseudotumour representing less than 1% of the cohort. We believe that the metallurgy of this interface and the exclusive use of 28mm heads has led to the successful survivorship of these THAs.

## **100. SURGICAL CORRECTION OF HIP DEFORMITIES AND ITS IMPACT ON THE DEGENERATIVE PROCESS WITHIN THE HIP JOINT**

**Presenter: Paul E. Beaulé, ON**

A. Speirs, ON, H. Anwander, Switzerland, G. Melkus, ON, K. Rakhra, ON, H. Frei, ON, M. Lamontagne, ON

Cam morphology in association with femoroacetabular impingement (FAI) is a recognised cause of hip pain and cartilage damage and proposed as a leading cause of arthritis. The purpose of this study was to analyse the functional and biomechanical effects of the surgical correction of the cam deformity on the degenerative process associated with FAI. We hypothesised that surgical correction of the cam deformity would alter the degenerative process in the cartilage and subchondral bone of the hip as measured by quantitative computer tomography and MRI biomarkers.

Ten male patients with cam-FAI who had undergone corrective surgery with a mean age of 34.3 years old (range: 23.1 – 46.5) and mean BMI of 26.66 kg/m<sup>2</sup> (SD: 4.79) were included. The inclusion criteria were: age less than 50 years, cam-FAI deformity, no prior hip surgery or post-traumatic deformity, a minimum two-year follow-up period. FAI was diagnosed based on clinical and radiological examination. The hip deformity was quantified using multi-planar imaging by assessing the femoral head-neck contour using the well-validated alpha angle. The alpha angle was measured on computed tomography (CT) images in oblique axial planes at 3:00 (Axial) and 1:30 (Radial) o'clock position. The cam-type deformity was defined as an alpha angle > 50.5 degree at 3:00 o'clock position or/and > 60 degree at 1:30 o'clock position. The mean axial and radial alpha angles were 53.6 degrees (Range: 45.6 - 67.2), and 66.4 degrees (Range: 56.8 – 74.1), respectively. Each patient completed a CT scan, MRI of the hips, squat motion analysis, and self-administered functional questionnaires (HOOS) both pre- and post-operatively.

At a mean follow-up of 24.5 months, functional scores and the squat performance improved significantly. Looking at the zone of impingement at the antero-superior acetabular rim, the mean change in BMD at follow-up was -31.8 mg/cc (95% CI: -11 to -53, p=0.008), representing a 5% decrease in BMD. This was also associated with significant decrease in T1rho; values reflecting a stabilisation of the cartilage degeneration. Significant correlations were noted between clinical functional scores and changes in T1rho; ( $r=-.86$ ,  $p=.003$ ) as well as the BMD and Maximum vector forces ( $r=.878$ ,  $p=.021$ ).

Using multiple objective end points, bone density and hip biomechanics, we have demonstrated that there is a direct cause and effect of surgical correction of the cam deformity with hip joint forces as well as overall condition of the cartilage. These changes showed reversal of changes in the acetabular bone leading to an alteration of the biochemical environment of the overlying cartilage. Surgical correction of a hip deformity in patients with symptomatic FAI not only improves clinical function but also significantly alters the degenerative process. These findings are the first to show that alteration of the hip biomechanics through surgical intervention improves the overall health of the hip joint.

## **101. QUANTITATIVE ANALYSIS OF MATERIAL LOSS AT THE HEAD-NECK JUNCTION IN TOTAL HIP ARTHROPLASTY: THE EFFECT OF HEAD SIZE, STEM MATERIAL AND STEM OFFSET**

**Presenter: Giuseppe Valente, ON**

B. Lanting, ON, M. Teeter, ON, D. Van Citters, ON, S. MacDonald, ON, J. Howard, ON

Corrosion and fretting at the head-neck junction in total hip arthroplasty may cause adverse clinical symptoms and implant failure. The predictive variables that lead to increased corrosion and fretting are widely debated throughout literature. The purpose of this study was to examine the effects of head size, stem material and stem offset on fretting and corrosion of the head-neck taper interface of a single trunnion design in retrieval implants of metal on polyethylene bearing surfaces.

A retrieval study was performed from our institutional implant retrieval database to identify all 28mm and 32mm femoral heads from a 12/14mm taper for a single implant design implanted for greater than two years. This included n = 56 of the 28mm heads (-3: n = 10, +0: n = 24, +4: n = 13, and +8: n = 9), and n = 23 of the 32mm heads (-3: n = 2, +0: n = 8, +4: n = 1, and +8: n = 6). The 28mm femoral heads were all matched to 32mm femoral heads on the basis of time *in vivo* and head length. A coordinate measuring machine was used to acquire axial scans within each head, and the resulting point clouds were analysed with a custom Matlab program. Maximum linear wear depth (MLWD) was calculated as the maximum difference between the material loss and as-machined surface. Differences in MLWD for head diameter, stem material, and stem offset were determined.

There were no differences between groups for age, gender, BMI, or implantation time. There was no difference in MLWD ( $p = 0.59$ ) between the 28 mm ( $5.9 \pm 6.2 \mu\text{m}$ ) and 32mm ( $5.5 \pm 6.2 \mu\text{m}$ ) matched paired head diameters. There was also no difference in MLWD ( $p = 0.79$ ) between titanium ( $5.2 \pm 5.9 \mu\text{m}$ ) or cobalt-chromium ( $6.2 \pm 6.4 \mu\text{m}$ ) stems, and no difference ( $p = 0.95$ ) between regular ( $5.5 \pm 5.3 \mu\text{m}$ ) or high-offset ( $6.3 \pm 8.8 \mu\text{m}$ ) stems.

Numerous previous studies examining corrosion and fretting at the head-neck junction in retrieval implants of metal on polyethylene bearing surfaces utilised visual damage scoring to quantify the amount of damage present. This study utilised a quantitative means to precisely measure the MLWD. There is no statistical difference in maximum linear wear depth at the head neck junction in total hip arthroplasty between 28mm and 32mm head diameters, titanium or cobalt-chromium stems, and regular or high offset stems.

## **102. COMPARING THE DIRECT ANTERIOR APPROACH WITH THE POSTERIOR APPROACH TO THE HIP: EARLY STEM MIGRATION AND COMPLICATIONS**

**Presenter: Kathryn Culliton, ON**

H. Louati, ON, G. Gharib, ON, J. Dobransky, ON, A. Pagé, ON, W. Gofton, ON, P.E. Beaulé, ON

The direct anterior approach (DAA) to the hip for total hip arthroplasty (THA) has proven to be less invasive and to lead to faster recoveries when compared to the posterior approach (PA). However, there remains concerns with regards to early complications, particularly femoral component under sizing and the association with migration and implant loosening. The objectives of this study were to 1) compare early stem migration rates following THA using the DAA with those done using the PA and 2) compare early clinical outcomes and complication rates in both cohorts.

All patients that underwent primary THA at our institution between January 1 2008 and December 31 2013 were reviewed. Inclusion criteria were: the use of a ProFemur TL stem (MicroPort), primary OA, and a metal on polyethylene head-liner combination. A single surgeon performed the DAA and two surgeons performed the PA surgeries. Migration evaluation was done using EBRA-FCA; radiographic exclusions were based on the software comparability standards and a minimum follow-up of two years. The one-year, two-year subsidence rates, and the percentage of patients to reach a subsidence of -1.5 and -2.7 mm in the first two years were calculated. These values were chosen as they have previously been associated with subsequent aseptic loosening. All patients were reviewed for complications throughout the follow-up duration. Clinical outcomes (Harris Hip, WOMAC, UCLA and SF-12) were also assessed pre-operatively and at two year follow-up.

At our institution, 388 hips (352 patients) fit the inclusion criteria. EBRA-FCA based exclusions resulted in DAA and PA groups sizes of 71 and 97 hips respectively. There were no significant differences in age, gender and BMI between groups. There were no significant differences in the one-year and two-year subsidence rates, and the total subsidence at 24-months between groups. A higher percentage of DAA hips reached subsidence values of -1.5 mm and -2.7 mm in the first two years compared to PA hips, 25% vs. 16% and 11% vs. 4%

respectively though the differences were not statistically significant (All  $p > 0.05$ ). Hips operated on using the PA had higher instances of dislocations, femoral fractures and a higher overall revision rate compared to hips operated on using the DAA, though none of these differences were statistically significant (All  $p > 0.05$ ). There was a significant increase in all clinical outcomes at 24-months with no differences between the two approaches.

While, in this early follow-up study, the DAA hip trended towards greater early subsidence, there was no association between the DAA and any significant increase in femoral component migration. The DAA was not associated with any increase in post-operative complications or subsequent revisions and resulted in similar clinical outcomes to PA treated hips. Mid-term and long-term data is required to assess if there exists a true increased risk of aseptic loosening secondary to migration in association with the DAA.

### **103. INCREASING BMI IN PRIMARY AND REVISION TOTAL HIP ARTHROPLASTY; INFLUENCING LENGTH OF STAY, COMPLICATIONS AND ADVERSE EVENTS. A RETROSPECTIVE REVIEW**

**Presenter: Irfan Abdulla, AB**

H. Khong, AB, S. Mahdavi, AB, R. Gill, AB, J. Powell, AB, K. Johnston, AB, R. Sharma, AB

Total hip arthroplasty (THA) is a reliable surgical option to treat pain and disability secondary to degenerative hip disease. THA has demonstrated improvements in overall health, quality of life and function. Obesity is a modifiable risk factor contributing to significant morbidity and is a contributing factor in the acceleration of degenerative joint disease. Using the data in the Alberta Bone and Joint Health Institute (ABJHI), the purpose of this study is to retrospectively compare length of stay, complications and adverse events in patients undergoing Primary or Revision hip arthroplasty with increased BMI to those with normal BMI.

We reviewed the data compiled in the ABJHI (Alberta Bone and Joint Health Institute) registry between March 2010 and July 2016. Ten thousand, nine hundred and two (6076 Female, 4826 Male) Primary arthroplasty (PA) patients and 717 (388 Female, 329 Male) Revision arthroplasty (RA) were included in the study. We reviewed outcomes with respect to length of stay, discharge destination, 30-day readmission, transfusion requirements, adverse events and in hospital post operative mechanical complications.

In Primary arthroplasty (PA), patients with Class II (43.9%) and Class III (47.4%) obesity were more likely to have two or more surgical risk factors. In Revision arthroplasty (RA) this was the case in all obesity classifications. ( $P < 0.0001$ ). Obesity had no effect on in-hospital periprosthetic fracture or dislocations and also not a risk factor for medical complications. In PA, class I (7.8%), II (6.7%) or III (6.3%) all had lower rates of blood transfusion compared to patients who were normal weight (17.2%). RA patients classified as overweight (22.8%), Class I obese (30.6%), Class II obese (18.3%), or Class III obese (22.0%) all had lower rates of blood transfusion compared to patients who were normal weight (34.8%). PA patients with BMI reaching class II (OR=1.64; 95% CI= 1.19-2.25), and III (OR= 1.59; 95% CI= 1.10-2.31) had higher rates of 30-day readmission while in RA patients, this risk was increased in class I (OR= 1.36; 95% CI= 0.57-3.25), class II (OR=1.47; 95% CI=0.53-4.08) and class III (OR= 1.98; 95% CI= 0.64-6.07) patient population. In PA, BMI values reaching class II (4.3 days) and class III (4.3 days) obesity had longer length of acute hospital stays than patients who were classified as normal weight, overweight or obese. In RA, Class I, Class II and Class III obese patients all had a longer acute length of hospital stay ( $p < 0.001$ ). In PA, class II (OR=1.72; 95% CI=1.37-2.16) and class III (OR= 3.16; 95% CI=2.44-4.08) obesity patients were less likely to be discharged home than patients with normal BMI while in the RA group this was the case for class III (OR= 1.25; 95% CI= 0.52-3.04) only.

Our study quantifies the effects of obesity in primary and revision hip arthroplasty. This data can help the physician and their patients understand the risks in the obese population when contemplating joint arthroplasty.

## COA Adult Reconstruction Knee

### **104. A COMPARISON OF FIXED AND MOBILE BEARING UNICOMPARTMENTAL KNEE ARTHROPLASTY AT MINIMUM 10-YEAR FOLLOW-UP**

**Presenter: Michael E. Neufeld, BC**

A. Albers, QC, N. Greidanus, BC, D. Garbuz, BC, B. Masri BC

There is little comparative data on outcomes of fixed vs. mobile bearing UKA at long-term follow-up from independent centres. The primary goal of our study was to compare the implant survivorship of fixed and mobile bearing UKA at minimum 10-year follow-up. Secondary goals were to evaluate and compare patient reported outcomes and modes of failure of both UKA designs, and to identify factors associated with revision.

Using our institutional database we identified a consecutive series of 106 primary medial UKAs performed in 89 patients between October 2000 and May 2006. Quality of life was measured pre-operatively (WOMAC, Oxford Knee Scores, SF-12) and at minimum 10-year follow-up together with patient-reported satisfaction. Radiographs were evaluated using Kellgren & Lawrence and Merchant scores pre-operatively and at latest follow-up. Revision to TKA or subsequent surgery to the affected knee was noted and the cause of failure determined. Kaplan Meier statistics were performed to evaluate 10-year implant survivorship with subgroup analysis performed for the two different implant designs. Proportional hazard models were used to evaluate predictors of revision to TKA.

There were 46 males and 43 females with a mean age of 63 years (41.4-84.3) at the time of surgery. Seven patients died within 10 years of the index procedure (no revisions). Eighty patients (95 knees) were alive at current follow-up (mean 12.5 years, range 10.1-15.5). Five patients were lost to follow-up. With revision to TKA as the end point, Kaplan Meier implant survival for the entire cohort was 88% at 10 years. Survivorship was 83% for the mobile bearing and 95% for the fixed bearing component (44 knees) in current use at our institution ( $p=0.079$ ). The mean time to revision was 7.7 years (range 0.8-14.5). Modes of failure were pain with radiographic progression of arthritis (53%), pain without radiographic progression of arthritis (40%), and symptomatic aseptic loosening (13%). Patients reported significant increases in all outcome scores compared to baseline and 92% of patients were very satisfied or somewhat satisfied with their operations. Patient reported outcomes between fixed and mobile bearing subgroups were similar ( $p>0.05$ ). No patient, radiographic, surgical, or implant variables evaluated were associated with revision to TKA ( $p>0.05$ ).

This study supports the use of UKA in treatment of medial compartment knee arthritis, showing suitable long-term results with both fixed and mobile bearing designs. Although the risk of revision to TKA between designs was non-significant, better survivorship was seen with the fixed bearing design. This may represent the exclusive use of mobile bearing implants during the initial learning curve performing UKA at our centre. Lastly, this series demonstrates outstanding survivorship and represents the longest follow-up in the literature for the fixed bearing component in current use at our institution.

### **105. A PROSPECTIVE COMPARATIVE STUDY BETWEEN SYNOVIAL JOINT BIOMARKERS IL-1BETA, TNF-ALFA VS. DIAGNOSTIC X-RAY FINDING USEFULNESS IN DIAGNOSTIC & THERAPEUTIC ASSESSMENT FOLLOW-UP OF KNEE JOINT OA GRADE II, III, A CLINICAL STUDY FOR TWO YEARS**

**Presenter: Ahmed Alkhuzai, Iraq**

We evaluate soluble mediators' synovial biomarkers IL-1 Beta, TNF-Alfa in knee joints aspirates, plus radiological x-ray finding in early diagnostic pre-treatment and post-therapeutic treatment in osteoarthritic knee joint patients grade II, III study follow-up for two years. Aim of study: to evaluate knee synovial joints biomarkers IL-1 Beta, TNF-Alfa level, plus radiological x-ray finding in diagnosis of knee osteoarthritis grades II, III early and post-therapeutic treatments follow-up.

In prospective comparative study patients with knee osteoarthritis grade II, III. To see the advantages of synovial aspirates of IL-1 Beta, TNF-Alfa biomarkers level, in compare to radiological finding of knee joints OA

grade II, III. Were randomised according to inclusion exclusion criteria into two groups. Group A 50 patients were depend on synovial aspirates of IL-1 Beta, TNF-Alfa biomarkers level from knee joints OA grade II, III early pretreatment then post therapeutic treatment period. Compared to group B 50 patients were depend on radiological x-ray finding alone in early pre-treatment plus post therapeutic treatment of knee joints OA in same grade II, III. The post therapeutic treatment in both groups will be used arthroscopic drilling with intra-articular injections of stem cell. The patients were followed up for 12, 24 months period.

In group A detection of synovial fluid aspirates of IL-1 Beta, TNF-Alfa biomarkers level from knee joints OA grade II, III in early pretreatment compare to post therapeutic treatment period showed significant reduction of these biomarkers level. Compare to group B were depend on x-ray alone in diagnosis then post therapeutic treatment will showed no obvious radiological change however, significant progressive clinical improvement with progressive reduction in the level of synovial fluid biomarkers during follow-up period 12, 24. (P-value < 0.0001).

We concluded that these synovial biomarkers mediators IL-1 Beta, TNF-Alfa are superior to radiological x-ray finding alone depending on progressive clinical improvement with progressive reduction in synovial biomarkers level for two years study.

## **106. ARTERIAL CALCIFICATION ON PRE-OPERATIVE KNEE RADIOGRAPHS AS A PREDICTOR OF POST-OPERATIVE CARDIOVASCULAR EVENTS FOLLOWING PRIMARY TOTAL KNEE ARTHROPLASTY**

**Presenter: David Cantu-Morales, ON**

J. de Beer, ON, D. Petruccelli, ON, C. Kabali, ON, M. Winemaker, ON

The most common cause of death after an elective Total joint replacement (TJR) is an acute Myocardial infarction (MI). The POISE trial reported that 6.9% of patients, with known risk for cardiovascular disease, undergoing non-cardiac surgery will experience a major adverse cardiac event. Some pre-operative clinical risk factors have been well defined but are absent in at least half of all the patients who suffer an MI, demonstrating a clear need for improved pre-operative risk stratification. Lower-extremity artery calcification (LEAC) has been shown to correlate with the presence of Coronary artery disease (CAD). The purpose of this study was to determine association of LEAC with post-operative Cardiovascular events (CVE) among Total knee arthroplasty (TKA) patients.

A cross-sectional study of TKA patients at one academic arthroplasty centre over one year was conducted. Pre-operative TKA radiographs were reviewed by two surgeon observers. Regression modeling was used to examine association of radiographic presence of LEAC and perioperative CVE, 30-day CVE readmit, and 30-day and one-year mortality. Adjusted Odds ratio (OR) and 95% confidence interval (CI) were reported.

The sample included 900 TKA patients. LEAC was identified in 21.1% (190/900) of patients. Of LEAC cases 1.6% had an acute MI vs. 0.1% of non-LEAC cases ( $p=0.031$ ). Perioperative CVE rate was 5.8% for LEAC vs. 1.5% for non-LEAC cases (0.002). Having a perioperative CVE was identified by the regression model as a significant risk factor for having LEAC (OR 2.83, 95% CI 1.09-7.35). Due to limited number of acute MI events, absence of 30-day CVE readmit, 30-day mortality and few one-year mortality events, computing OR for these variables was not possible. The odds of LEAC cases having an acute MI was 11.37 (95% CI 0.09-597.93) however due to large random errors this finding must be interpreted with caution. The OR associated with one-year mortality was 1.88 (95% CI 0.17-13.20) but random errors were also large.

Our study shows that LEAC around the knee is associated with an increased risk of having a perioperative CVE (OR 2.83, 95% CI 1.09-7.35). While our data shows some association between LEAC and risk of acute MI, the very wide CI suggests that we cannot make a firm conclusion on this finding. The 1.6% perioperative MI event rate however, is clinically relevant given the previously reported perioperative MI rate of 0.9% among TJR patients at our institution over a 12-year period, which is in keeping with other reported rates of 0.25% to 1.9% following TJR. It is our contention that crude detection of LEAC has the potential to improve risk stratification by informing the surgeon of the need for further pre-operative cardiac workup. Given the importance of truly informed consent for an elective surgical procedure, this enhances the surgeon's ability to more accurately inform TKA patients regarding their individual perioperative risk of a CVE.



## **107. EVALUATION OF CONVENTIONAL AND PATIENT-SPECIFIC INSTRUMENTATION IN TOTAL KNEE ARTHROPLASTY USING RADIOSTEREOMETRIC ANALYSIS**

**Presenter: Douglas Naudie, ON**

E. Vasarhelyi, ON, J. Marsh, ON, J. Howard, ON, M. Teeter, ON, R. McCalden, ON, X. Yuan, ON

Patient specific instrumentation (PSI) for total knee arthroplasty (TKA) was introduced to increase efficiency and reduce operating room (OR) time. The cost-effectiveness of this technology has been questioned, however, and evaluation with Radiostereometric analysis (RSA) has been limited. The purpose of this study was to evaluate PSI compared to Conventional instrumentation (CI) for TKA with regards to resource utilisation, surgical waste, patient outcomes, radiographic alignment, cost, and implant migration with RSA.

The study was designed as a prospective, randomised controlled trial of 50 patients, with 25 patients each in the PSI and CI groups, powered for the RSA analysis. Patients in the PSI group received an MRI and standing three-foot x-rays to construct patient-specific cut-through guides for the femur and tibia. All patients received the same posterior-stabilised implant with marker beads inserted in the bone around the implants. Intra-operative variables such as time, number of instrumentation trays used, and mass of surgical waste were recorded. Outcome measures (WOMAC, SF-12, EQ5D, and UCLA) were recorded pre- and post-operatively. All costs associated with the procedure were recorded, including length of time in the OR, equipment opened, in-hospital stay, and any costs associated with complications or additional surgical procedures. Patients underwent supine RSA exams at multiple time points. Migration of the tibial and femoral components was calculated using model-based RSA software.

There were no demographic differences between groups. The PSI group required less instrument trays than the CI group (mean 4.8 vs. 8.1 trays,  $p < 0.0001$ ), but procedure time was equivalent (mean 79 vs. 74 min,  $p = 0.06$ ). The PSI group produced less recyclable waste (mean 0.3 vs. 1.4 kg,  $p < 0.001$ ), but total waste was equivalent between groups (mean 10.1 vs. 10.6 kg,  $p = 0.32$ ). At six months, there was no difference between groups for WOMAC, SF-12, EQ5D, or UCLA scores. One patient in the PSI group was revised for infection, and three patients required manipulation, with no revisions or manipulations in the CI group. The average cost per procedure was significantly greater for the PSI group than the CI group (mean difference = \$1,787.38, 95% CI = 951.10 to 2623.67,  $p < 0.01$ ). At six months, there was no difference in maximum total point motion between groups for the tibia (mean 0.50 vs. 0.50 mm,  $p = 0.98$ ) or femur (mean 0.46 vs. 0.48 mm,  $p = 0.87$ ).

The PSI group provided minimal or no advantage over the CI group for operative time, instrumentation used, or surgical waste produced. There was an increase in the need for manipulation in the PSI group. Although the PSI group did require fewer instrument trays, this did not offset the additional pre-operative and surgical procedure costs. At early RSA follow-up, the two groups were broadly similar in implant fixation and demonstrated acceptable migration patterns.

## **108. POOR OUTCOME OF ARTHROLYSIS, SYNOVECTOMY AND LINER CHANGE FOR STIFFNESS AFTER PRIMARY TOTAL KNEE ARTHROPLASTY**

**Presenter: Nelson V. Greidanus, BC**

D. Garbuz, BC, B. Masri, BC, A. Herman, Israel

Knee stiffness is a complication following knee arthroplasty which can result in compromised range of motion, reduced patient-reported quality of life, and dissatisfaction. Surgical options include arthroscopic arthrolysis, open arthrolysis synovectomy and liner downsizing and revision of components. The purpose of this study was to specifically describe the patient-reported outcomes and range of motion associated with knee revision surgery involving arthrolysis, synovectomy and liner downsizing.

We performed a retrospective study, using our institutional arthroplasty database to identify patients with knee revision for stiffness who obtained arthrolysis, synovectomy and liner change (no femoral or tibial component revision) and reviewed these patients to evaluate quality of life, satisfaction, and range of motion outcomes. Patients were a minimum of two years after revision surgery at the time of their most recent review. All

patients completed quality of life questionnaires: Short-Form 12 (SF-12), Oxford knee score (worst score: 0 best score: 48) and WOMAC overall, pain, stiffness and function scores (normalised scale: 0-100) and patient reported satisfaction (0-100: worst-best). Range of motion outcome was recorded using a goniometer.

We identified 583 revision knee procedures which were performed between the years 2007-2014. There were 42 patients who specifically received arthrolysis, synovectomy, and liner change without any revision of femoral or tibial prosthesis, for stiffness after primary knee replacement. Twenty five of these patients completed the study. Mean follow-up time was 4.8 years (SD=2.1) and at a mean time from TKR to revision surgery of 1.9 years (SD=2.4). Range of motion improvement occurred across the cohort with a mean extension and flexion improvement of six degrees (SD=16.3) and 20.9 degrees (SD=32.8), respectively. Mean pre-revision and post-revision range of flexion (ROM) were 56.6 (SD=25.6) and 75.6 (SD=35.16) degrees, respectively. Mean improvement in the overall arc of motion was 26.9 degrees (SD=29.8). Patient reported quality of life was as follows: mean SF-12 physical and mental score were 43.23 (SD=20.66) and 62.66 (SD=19.21), respectively. Oxford knee score mean 24.5 (SD=9), WOMAC overall score 47.9 (SD=17.4), and WOMAC pain, stiffness, and function domain scores were: 45.3 (SD=19.4), 53.3 (SD=22.1) and 48.6 (SD=18.4), respectively. Mean satisfaction score was 45.2 (SD=37.5). Satisfaction score, overall WOMAC score, WOMAC stiffness and function were better in patients that had final flexion greater than 90 degrees.

Surgical arthrolysis, synovectomy, and liner change results in an improvement in observed and recorded knee range of motion however quality of life scores demonstrate significant residual disability and the majority of patients are dissatisfied. A subgroup of patients with a final arc of flexion greater than 90 degrees demonstrated an improved outcome. Surgeons and their patients should be aware that this procedure is not likely to provide a significant functional improvement in range of motion, and are likely to report a poor functional outcome and dissatisfaction. Armed with this information, most patients would opt to avoid this surgical intervention.

## **109. DOES SURGEON ARTHROPLASTY VOLUME REALLY AFFECT PATIENT OUTCOMES?**

**Presenter: Jason Werle, AB**

H. Khong, AB, C. Smith, AB

The literature suggests that higher volume arthroplasty surgeons have better patient outcomes. This study compares the outcomes of surgeons that perform a low annual volume ( $\leq 50$  cases per year) to surgeons that perform a high annual arthroplasty surgical volume ( $> 50$  cases per year) within the Canadian context.

This study evaluates the outcomes of all patients undergoing primary total hip, primary total knee, hip resurfacing, or unicompartmental knee arthroplasties in 13 hospitals in Alberta from January 1, 2010 to December 31, 2014. Surgeon volume was divided into low ( $\leq 50$  arthroplasties per year) and high ( $> 50$ /year). Outcome measures included Acute and Total Length of Stay (LOS), inpatient mortality rates, WOMAC at three months post-op, EQ5D at three months post-op, transfusion rates, deep infection rates, mechanical adverse events, medical adverse events, and readmission rates. Outcomes were risk-adjusted for age, gender, procedure, and pre-surgery risk factors. Chi-square test was used to compare categorical variables in two or more groups. Exact-test was used to compare very rare events (ie. mortality). T-test was used to compare the means of two groups and Anova was used to compare the means of three or more groups.

A total of 38,755 patients were included in the study at 13 hospitals. The surgeries were performed by a total of 88 different surgeons. Twenty-two surgeons were considered low-volume and 66 were considered high-volume. Procedures performed by low-volume surgeons numbered 1,500. Procedures performed by high-volume surgeons numbered 37,255. High-volume surgeons treated a greater number of patients with no pre-surgical risk factors and slightly younger patients (mean age 66.4 vs. 67.6,  $p < 0.001$ ). There were no significant differences in pre- or post-op WOMAC or EQ5D patient reported outcomes between the two surgeon groups. There were no significant differences in medical adverse events, mechanical adverse events, deep infection rates, or readmission rates between the low-volume and high-volume surgeon groups. High-volume surgeons had significantly lower Acute LOS (4.2 days vs. 4.9 days,  $p < 0.001$ ) and significantly lower transfusion rates (15.5% vs.

18.9%,  $p < 0.001$ ). Low-volume surgeons had significantly higher inpatient mortality rates (2.7% vs. 0.6%,  $p = 0.002$ ).

This study compares the outcomes of primary arthroplasty surgery performed by low-volume ( $\leq 50$ /year) and high-volume ( $> 50$ /year) surgeons in Alberta. It is reassuring that the results for patient reported outcome measures, medical adverse events, mechanical adverse events, readmission rates and infection rates were similar regardless of surgeon volume. High-volume surgeons had a lower mean LOS, lower transfusion rates, and lower inpatient mortality rates. These findings have implications for inpatient hospital costs and resource planning.

#### **110. TIBIAL POST FATIGUE FRACTURE IN POSTERIOR STABILISED TOTAL KNEE ARTHROPLASTY USING HIGHLY CROSS-LINKED POLYETHYLENE**

**Presenter: Owen Diamond, UK**

B. Masri, BC

Highly Cross-Linked Polyethylene has been accepted as a definite improvement in outcomes for total hip replacement. In total knee arthroplasty, despite improved wear characteristics, highly cross-linked polyethylene has not been as ubiquitously accepted, mainly due to concerns about reduced strength, fatigue resistance and fracture toughness. In particular, in posterior stabilised total knee arthroplasty there are concerns about increased risk of fracture of the tibial post.

This is a report of five cases of tibial post fracture from a single surgeon series of 955 consecutive posterior stabilised total knee arthroplasty using Prolong highly cross linked polyethylene using the Nexgen PS-High Flex total knee system. Between April 1<sup>st</sup> 2007 and January 17<sup>th</sup> 2016, 955 posterior stabilised total knee arthroplasty cases were performed using Prolong highly cross-linked polyethylene under the care of a single surgeon. The departmental arthroplasty database identified five cases of revision knee surgery for fracture of the tibial post. The same surgeon also has performed 2,943 cases using the same posterior stabilised total knee arthroplasty system but with conventional polyethylene and there are no reported cases of tibial post fracture.

Five cases of tibial post fracture from 955 total knees with Prolong polyethylene gives a conservative estimate of the frequency of this complication of 0.52%. All five cases presented at with either increasing pain or instability and giving way, in previously well functioning total knees. There was no history of trauma or precipitating incident. Mean time to presentation and diagnosis was 57.2 months (Range 25 - 94). Successful treatment of involves revision surgery by exchange of the polyethylene liner to a conventional cross-linked polyethylene.

Given the increased risk of tibial post fracture with highly cross-linked polyethylene presented here and no definite clinical advantage ever displayed over conventional polyethylene when reviewing the literature, we would advocate against the routine use of highly cross linked polyethylene in posterior stabilised total knee arthroplasty. It is understood that fabrication techniques vary widely among highly cross-linked polyethylene products and therefore these results are representative of the risk only with this particular polyethylene in this posterior stabilised total knee system.

#### **112. CONTRIBUTION OF NON ORTHOPAEDIC SURGEON ORDERED MRI TO THE DIAGNOSIS AND MANAGEMENT OF KNEE PAIN IN PATIENTS OLDER THAN 55 YEARS**

**Presenter: Thomas M. Hupel, ON**

P. Grosso, ON, R. Lau, ON, M. Snider, ON, S. Yoon, ON

Despite the overall decline in the number of knee arthroscopies performed for knee osteoarthritis with or without a meniscal lesion, our group has noted an increasing trend towards patients presenting for orthopaedic consultation with a pre-consult MRI, ordered by a non-orthopaedic physician. We hypothesise that in a majority of cases a pre-consult MRI does not contribute to the establishment of a diagnosis and management plan for knee pain.

This is a retrospective review of prospectively collected patients, greater than the age of 55, referred to an orthopaedic surgeon with knee pain. All patients had an MRI of the knee prior to orthopaedic consultation. The

data collected include: patient demographics, whether or not a pre-MRI plain radiograph was performed, and the consulting surgeon's opinion on whether the MRI was required in establishing the diagnosis and management of the patient's knee pain. The MRI was determined to be useful if it confirmed the diagnosis of a symptomatic meniscal tear by the consultant and determined to be not useful if the patient's symptoms resolved at the time of consultation or if a clear diagnosis of symptomatic osteoarthritis was established by plain radiographs.

Overall 103 patients with 110 pre-consult MRIs were identified from October 2015 to October 2016. There were 58 women and 45 men, ranging in age from 55 to 91, with a mean age of 64. Sixty percent (61/103) of patients were referred for a meniscal tear identified by MRI. Only 46/103 patients (45%) had a knee radiograph prior to the MRI. In 78% of cases the pre consult MRI did not contribute to the clinical diagnosis established by the orthopaedic surgeon. Seventy-three percent of patients were diagnosed with osteoarthritis based on history, physical exam, and plain radiographs; the MRI was determined to be non-contributory to the diagnosis. According to age distribution, the contribution of MRI imaging to the establishment of a diagnosis was as follows: age 55-59, pre consult MRI was useful in 43% of cases, age 60-64, 18% useful, 65-69, 17% useful, 70-74, 15% useful, greater than 75, 0% useful.

Overall this prospective case study demonstrates that in patients age 55 or older, the vast majority (78%), did not require an MRI for the diagnosis or management of knee pain by an orthopaedic surgeon. This study also highlights the low frequency in which knee radiographs are completed in the setting of knee pain. Further study needs to be done around the work-up of knee pain in primary care. Improved access to orthopaedic surgeons and/or limiting the access to MRI until after orthopaedic consultation, could result in significant savings to the health care system.

## **COA Trauma**

### **113. PREDICTING LOSS TO FOLLOW-UP RISK IN ADULT TRAUMA PATIENTS IN RANDOMISED CONTROLLED TRIALS: AN EXAMPLE FROM THE FLOW TRIAL**

**Presenter: Kim Madden, ON**

T. Scott, ON, P. McKay, ON, B. Petrisor, ON, K. Jeray, NC, S. Tanner, NC, M. Bhandari, ON, S. Sprague, ON, FLOW Investigators, ON

High loss-to-follow-up (LTF) rates are a risk to even the most rigorously designed randomised controlled trials (RCTs). We hypothesise that certain baseline characteristics are associated with greater likelihood of being LTF. Our primary objective was to determine which baseline characteristics are associated with LTF within 12 months of an open fracture in adult trauma patients participating in the Fluid Lavage of Open Wounds (FLOW) trial.

Data for this study are taken from the FLOW trial. We conducted a binary logistic regression analysis with LTF as the dependent variable to determine patient characteristics associated with higher risk of LTF.

Complete data were available for 2,381 out of 2,447 participants. One hundred and sixty three (6.7%) participants were LTF. Participants who received treatment in the United States were more likely to be LTF than those who received treatment in other countries (OR: 3.28, 95% CI: 2.29 ±822; 4.71, p<0.001). Participants who were male (OR=1.59, 95% CI: 1.05 ±822; 2.41, p=0.29), current smokers (OR=1.73, 95% CI: 1.22 ±822; 2.44, p=0.002), or consumed a higher number of alcoholic drinks per week (OR=1.01, 95% CI: 1.0 ±822; 1.03, p=0.045) all had significantly higher odds of being LTF. Conversely, participants who are older (OR=0.98, 95% CI: 0.97 ±822; 0.99, p=0.002), sustained polytrauma (OR=1.49, 95% CI: 0.35 ±822; 0.69, p<0.001), or had a Gustilo-Anderson Type IIIA/B/C fracture (OR=0.56, 95% CI: 0.37 ±822; 0.85, p=0.007) had lower odds of being LTF. Work-related injury and Gustilo-Anderson type II fractures were not significantly associated with LTF.

Despite intensive efforts to minimise LTF in the FLOW trial, nearly 7% of participants were LTF. Males, current smokers, participants who consume more alcohol, and participants in the US are more likely to be LTF and therefore, strategies should be targeted at these participants.

#### **114. PATIENT COPING AND EXPECTATIONS ABOUT RECOVERY PREDICT DEVELOPMENT OF CHRONIC POST-SURGICAL PAIN, PAIN INTERFERENCE, AND REDUCED QUALITY OF LIFE AFTER TRAUMATIC OPEN EXTREMITY FRACTURE REPAIR**

**Presenter: Jason Busse, ON**

S. Makosso-Kallyth, ON, B. Petrisor, ON, K. Jeray, NC, T. Tufescu, MB, Y. Laflamme, QC, P. McKay, ON, R. McCabe, ON, Y. Le Manach, ON, M. Bhandari, ON, FLOW Investigators, ON

Within the orthopaedic community, there has been an increasing interest in the role that psychological factors, including patients' beliefs and attitudes regarding their medical condition, play in their recovery from severe physical trauma. The purpose of this study is to explore the role of patients' beliefs regarding their recovery on persistent pain, quality of life, and pain interference after traumatic open extremity fracture.

We previously developed and validated an instrument designed to capture the impact of patients' beliefs on functional recovery from injury; the Somatic Pre-occupation and Coping (SPOC) questionnaire. At both one and six weeks post-surgical fixation, we administered the SPOC questionnaire to a separate population of 1,360 patients with operatively managed open extremity fractures. We constructed multi-variable regression models to explore the association between SPOC scores and pain and functional outcome at one year, as measured by the short form-12 (SF-12) and the EuroQol-5D.

Of 1,111 open fracture patients with data available for analysis, 725 (65%) reported pain at one year. Addition of SPOC scores to an adjusted regression model to predict persistent pain improved the c-statistic from 0.66 to 0.73 ( $p < 0.001$  for the difference) and found the greatest risk was associated with high ( $\geq 78$ ) SPOC scores (OR 5.29, 95% CI 3.75 to 7.46). Thirty-six percent (406 of 1125) reported pain interference at one-year. Addition of SPOC scores to an adjusted regression model to predict pain interference improved the c-statistic from 0.66 to 0.74 ( $p < 0.001$  for the difference) and found the greatest risk was associated with high SPOC scores (OR 5.83, 95% CI 4.12 to 8.26). In our adjusted multivariable regression models, SPOC scores at one-weeks post-surgery accounted for 11% of the variation in SF-12 physical component summary scores and 13% of SF-12 mental component summary scores at one-year. All associations were conserved with one week SPOC scores, but the magnitude of associations for SPOC scores at six-weeks was significantly larger across all models.

Patient's coping and expectations of recovery, as measured by the SPOC questionnaire, is a strong predictor of persistent pain, quality of life, and pain interference after traumatic open extremity fracture. Future studies should explore whether these beliefs can be modified, and if doing so improves prognosis.

#### **115. FAILURE PATTERNS OF YOUNG FEMORAL NECK FRACTURES: WHICH COMPLICATIONS SHOULD WE CHOOSE?**

**Presenter; David J. Stockton, BC**

K. Dua, MD, P. O'Brien, BC, M. Hoshino, CA, A. Pollak, MD, G. Slobogean, MD

The higher functional demands of non-geriatric patients with femoral neck fractures often necessitate surgical fixation instead of arthroplasty management. While it is unclear if implant selection can improve fracture healing outcomes, it is also unknown if the fixation failure patterns in adult patients resemble osteoporotic failures or if the patterns are associated with the surgical implant selected. The purpose of this study was to describe the failure patterns of young femoral neck fracture fixation, and secondarily to determine if the pattern of failure varies by implant type.

Adult patients (ages 18-55) that experienced a "fixation failure" following internal fixation of a femoral neck fracture were identified from five Level One trauma centres. Failure was defined by screw cutout, implant breakage, varus collapse ( $< 120^\circ$  neck-shaft angle), or severe fracture shortening ( $\geq 1$ cm). When multiple complications were identified, mechanical failures were preferentially noted for the analysis. The chi-square statistic and fisher's exact-test was used to compare the failure patterns between patients that received multiple cancellous screws vs. a sliding hip screw  $\pm$  derotation screw (SHS).

Forty-four patients with treatment failures were identified from the overall cohort of 215 patients. Twenty-eight patients with fixation failures were treated with multiple cancellous screws, while the remaining patients received a SHS construct. The failure rate for cancellous screws was 24%, while SHS fixation failed 19% of the time. Severe fracture shortening was the most common complication identified (61%), followed by screw cutout (18%), varus collapse (16%), and implant breakage (5%). A significant difference in the distribution of failure patterns was identified between the treatment groups ( $p=0.024$ ). No differences in the incidence of severe shortening ( $p=0.750$ ) or implant breakage ( $p=1.000$ ) were detected between the fixation groups; however, fixation method was associated with varus collapse and screw cutout. Among the failures with a SHS construct, a greater portion were related to screw cutout (SHS 38% vs. screws 7%,  $p=0.019$ ); whereas, failures from multiple screws were more commonly associated with varus collapse (Screws 25% vs. SHS 0%,  $p=0.037$ ).

Severe shortening is the most common fixation failure and neither implant appears to prevent this complication. Our results confirm that femoral neck fracture fixation in younger adults fail in a similar pattern as elderly patients: SHS constructs are associated with screw cutout, and multiple cancellous screws typically fail by varus collapse. While neither fixation technique has demonstrated improve fracture healing outcomes, selecting a surgical implant based on its likely failure pattern may allow surgeons to minimise the severity of the failure or its need for secondary conversion to hip arthroplasty.

## **116. SIMPLE DECOMPRESSION VS. ANTERIOR TRANSPOSITION OF THE ULNAR NERVE FOR DISTAL HUMERUS FRACTURES TREATED WITH PLATE FIXATION - A MULTICENTRE RANDOMISED CONTROLLED TRIAL**

**Presenter: E. Schemitsch, ON**

N. Dehghan, ON, M. Vicente, ON, A. Nauth, ON, J. Hall, ON, M. McKee, ON, Canadian Orthopaedic Trauma Society

Isolation, decompression and protection of the ulnar nerve is required for the fixation of distal humerus fractures performed through a posterior approach. The management of the ulnar nerve at the conclusion of the surgical procedure is a matter of controversy, focused upon either leaving the nerve *in situ*, vs. anterior transposition. This study sought to address this controversy by comparing simple decompression to anterior subcutaneous transposition of the ulnar nerve following plate fixation of fractures of the distal humerus.

This is a multicentre randomised controlled trial performed across eight trauma centres in Canada. All patients underwent dual plate fixation of a distal humerus fracture, and were randomised to receive either 1) simple decompression or 2) anterior subcutaneous transposition of the ulnar nerve at the conclusion of the procedure. Inclusion criteria were: age 16-80 years; displaced distal humerus fractures (OTA 13A, 13C),  $\leq 28$  days post-injury; closed or grade I/II open fractures. Comprehensive neurological, functional, sensory, motor, and electrophysiological outcome assessments were conducted. The primary outcome was the Ulnar Nerve Entrapment Score classification system of Gabel and Amadio. Patients were followed at six weeks, three months, six months, one year post-operatively.

Thirty-one patients were randomised to decompression, and 27 to anterior transposition. The mean age was 52 years, and 60% were female. There was no difference between the two groups with regards to age, sex, BMI, smoking, diabetes, injury characteristics, time to OR, length of OR, or surgical approach. Overall, ulnar nerve symptoms and functional outcomes significantly improved from baseline to one year post-operatively. When comparing outcomes of simple decompression and anterior transposition, there was no difference between the two groups at any time point with regards to Ulnar Nerve Entrapment Score, MEPS scores, DASH, VAS, or two-point discrimination. An abnormal nerve conduction study was present in 62% of patients, with no difference between the two groups. Complications included four superficial wound infections, two deep infections, four nonunions, and 11 revision surgeries, and were equally distributed between the two groups.

This randomised controlled study demonstrates that the majority of patients with plate fixation of a distal humerus fracture develop symptoms of ulnar nerve irritation post-injury, however the majority improve by one year post-surgery. Functional outcomes also improve significantly in the first year. There was no difference in

ulnar nerve symptoms, outcomes, or complications, between treatment with simple decompression or anterior transposition of the ulnar nerve. Either strategy for managing the ulnar nerve is acceptable, and can be used at the discretion of the treating surgeon.

### **117. DOES THE IMMEDIATE POST-OPERATIVE RADIOGRAPH CHANGE PATIENT MANAGEMENT AFTER SURGICAL FRACTURE FIXATION? A SYSTEMATIC REVIEW**

**Presenter: Tammie Teo, BC**

E. Schaeffer, BC, A. Cooper, BC, K. Mulpuri, BC

Immediate post-operative radiography is often performed 0-3 days after fracture fixation to check adequacy of reduction and identify complications or need for re-manipulation. However, recent publications suggest that if not clinically indicated, it may not provide enough useful information to warrant the cost and excess radiation. We performed a systematic review of available literature to evaluate immediate post-operative radiography in the management of patients who have undergone fracture fixation.

A systematic review was conducted according to PRISMA guidelines using the MEDLINE, EMBASE, CDSR, CENTRAL and Google Scholar databases encompassing the years 1946-2016. Two independent reviewers screened potential studies for inclusion and resolved disagreements through discussion or third-party opinion. Only RCTs, non-randomised controlled trials and prospective and retrospective cohort studies that included an immediate post-operative radiograph and directly addressed management changes in upper extremity, lower extremity and hip fractures were eligible for inclusion. Data were independently extracted using predefined data fields. A random-effects model was applied and pooled effects were calculated based on available data.

In total, 702 articles were identified. After full-text review, 12 articles (one prospective, 11 retrospective cohort studies) were included for data extraction. Of these, six (50%) examined patients with femoral neck fractures, two (17%) ankle fractures, two (17%) forearm fractures, one (8%) tibial shaft fracture and one (8%) both upper and lower extremity fracture. Post-operative radiographs were taken within zero to three days of surgery in all studies. Reported patient ages ranged from 0.92-103 years. All outcomes were reported in patient and/or fracture numbers. Combining the 11/12 articles that reported by patient numbers, the absolute benefit increase (ABI) of immediate post-operative radiography in identification of complications was 0.86% (95% CI: 0.54-1.35%; number needed to treat (NNT) = 116). The ABI for management change was 0.26% (95% CI: 0.11-0.59%; NNT = 386). One article reported outcomes exclusively by fractures and was not included in quantitative analysis; however, zero complications or management changes were found over the 67 fractures studied.

Current literature suggests that immediate post-operative radiography does not lead to management change in the majority of patients after fracture fixation. Removal of potentially unnecessary radiography would decrease radiation exposure in patients and increase resource availability for other hospital needs. More comprehensive reporting, along with further prospective comparative research, will be necessary to increase the level of evidence. Given the remodeling potential in paediatric patients, there is an even lower likelihood of post-operative radiography leading to management change; further studies are thus needed specifically for the paediatric population.

### **118. THE TRAJECTORY OF SHORT AND LONG-TERM RECOVERY OF TIBIAL SHAFT FRACTURES FOLLOWING INTRAMEDULLARY NAIL FIXATION**

**Presenter: Sebastian J. Ko, BC**

P. O'Brien, BC, P. Guy, BC, H. Broekhuysse, BC, P. Blachut, BC, K. Lefavre, BC

We performed a study to determine the trajectory of recovery following tibial shaft fracture treated with intramedullary nail over the first five years, and to evaluate the magnitude of the changes in functional outcome at various time intervals.

With ethics board approval, data were prospectively collected on patients at least 18 years of age who sustained a tibial shaft fracture (OTA 42-A,B,C), treated with intramedullary nailing at a Level 1 Trauma Centre. Basic demographic and injury information was collected, including age, gender and injury severity score (ISS). Patients were asked to complete two functional outcome questionnaires: the short form (SF)-36 and short musculoskeletal function assessment (SMFA) at baseline (pre-injury recall), six months, 12 months, and five years. Pre-injury recall was utilised for baseline scores, as it has been suggested with functional questionnaires to be more appropriate than general population norms. The SF-36 is a validated, reliable, functional questionnaire constructed on normal population data to reflect the general health status of patients. The SF-36 is a 36-item questionnaire that is summarised into a physical component score (PCS) and a mental component score (MCS). A higher SF-36 score implies higher function. The SMFA is a validated, two-part 46-item functional questionnaire specific to patients with musculoskeletal injuries. It is divided into a dysfunction index and a bother index. With the SMFA, a lower score implies higher function. Mean functional outcome was calculated at each time point using each questionnaire, and statistical significance of the difference in means between time points was calculated. The minimum clinically important difference (MCID) can be described as the smallest change in an outcome score that patients perceive as important. By convention, the MCID for the SF-36 and SMFA is five points, and the proportion of patients making a clinically important change at each time point was calculated.

Mean SF-36 physical component scores improved between six to 12 months ( $p=0.0008$ ) and between one to five years ( $p=0.0029$ ). Similarly, mean SMFA physical function scores improved between six to 12 months ( $p=0.0254$ ) and between one to five years ( $p=0.0106$ ). In both scores, the rate or slope of this improvement is flatter between one to five years than it is between six to 12 months. Furthermore, SF-36 and SMFA scores did not reach baseline at five years (SF-36  $p < 0.0001$ , SMFA  $p=0.0026$ ). SF-36 detected that 52% of patients were still achieving MCID in the one to five year interval.

The trajectory of functional recovery after tibial shaft fracture is characterised by an initial decline in function, followed by improvement between six to 12 months. There is still further improvement beyond one year, but this is of flatter trajectory. The five-year results indicate that function does not improve to baseline by five years post-injury.

## **119 - OPERATIVE TREATMENT OF DISPLACED MIDSHAFT CLAVICLE FRACTURES: HAVE EVIDENCE-BASED RECOMMENDATIONS CHANGED PRACTICE PATTERNS?**

**Presenter: Prism Schneider, AB**

J. Agel, OR, R. Bransford, OR, E. Harvey, QC

In 2007, members of the Canadian Orthopaedic Trauma Society (COTS) conducted a randomised clinical trial (RCT) comparing open reduction and internal fixation (ORIF) with non-operative management of displaced midshaft clavicle fractures (COTS, 2007). The findings were improved functional outcome scores and decreased mal-union and non-union rates with ORIF. A survey of members of the Canadian Orthopaedic Association reported 73% of respondents stated that the COTS RCT changed their practice pattern (Khan et al., 2013). However, to date, this perceived change in practice pattern has not been quantified. This study aimed to quantify practice pattern changes for management of displaced mid-shaft clavicle fractures.

This study is a dual-centre, retrospective radiographic review comparing treatment patterns prior to and following the RCT published by COTS in January 2007. Eligible patients were identified through data registries as being aged 16 to 60 years of age with displaced mid-shaft clavicle fractures (AO/OTA 15B-1, 15B-2, 15-B3) between January 2001 and December 2014 at each of the two participating Level 1 trauma centres. Exclusion criteria were open fractures, pathological fractures, or patients previously enrolled in the COTS trial. Two groups were identified: Pre-trial cohort (injury date between January 2001 to January 30, 2003 - prior to COTS study enrolment) and Post-trial cohort (January 2007 to December 2014). Statistical analysis used independent samples T-tests for comparing groups, with significance established at  $p < 0.05$ . Odds ratios (OR) were calculated for subgroup analysis of gender, age ( $< 40$  years vs.  $> 40$  years), and pre and post-trial.



A total of 686 patients met inclusion criteria. The pre-trial cohort (n = 108) was comprised of 76.1% males, with a mean age of 37.7 ( $\pm$  13.9) years. The post-trial cohort (n = 578) was comprised of 68.5% males, with a mean age of 41.9 ( $\pm$  12.7) years. The mean Injury Severity Score (ISS) for the pre-trial group was 21.3 ( $\pm$  13.8), compared to the post-injury cohort mean ISS of 25.1 ( $\pm$  13.7) (p = 0.01). There was no significant difference between groups for gender (p = 0.117), however the pre-trial cohort was younger (p = 0.005) compared with the post-trial cohort. There were no differences between the participating sites for age or gender. There was nearly a 10-fold significant increase in the proportion of patients treated with ORIF from the pre-trial cohort (3.7%) to the post-trial cohort (34.1%) (p <0.001). Patients were more likely to undergo ORIF if their age was <40 years (OR = 2.2, 95% CI = 1.53-3.10) or if they were treated at a participating study centre (OR = 5.2; 95% CI = 3.32-8.21). There was a trend towards increased ORIF for patients with an ISS >9 (OR=1.6; 95% CI = 0.89-2.99). There was no increased likelihood of surgical treatment based on gender.

Quantifying changes in practice pattern following publication of evidence-based recommendations is important to further our understanding of the impact large RCTs are having on clinical practice, duration of time required for practice patterns to change, and the longevity of practice pattern changes. This study demonstrated a significant practice pattern shift towards more frequent ORIF for displaced mid-shaft clavicle fractures following the COTS trial and a greater change in practice within centres participating in the RCT.

## **120. A COST-ANALYSIS OF TREATMENT STRATEGIES FOR COMMINUTED THREE AND FOUR PART PROXIMAL HUMERUS FRACTURES IN ELDERLY INDIVIDUALS: A COMPARISON OF CONSERVATIVE AND OPERATIVE MANAGEMENT APPROACHES**

**Presenter: Herman Johal, ON**

B. Ristevski, ON, K. Rajaratnam, ON, M. Denkers, ON, M. Bhandari, ON

Comminuted proximal humeral fractures in the elderly remain a treatment challenge with variable and frequently unsatisfactory outcomes. Reverse total shoulder arthroplasty (RTSA) in the acute setting has potential to yield improved outcomes given positive outcomes among the rotator cuff deficient elderly population; however, higher associated treatment costs have fuelled arguments against its routine use. The purpose of this study was to evaluate the cost-effectiveness of conservative and operative management options in the treatment of displaced, comminuted three and four part proximal humerus fractures in the elderly. Treatment strategies examined included non-operative, ORIF, hemiarthroplasty and RTSA.

A decision-analysis model was constructed to estimate the cost-effectiveness of conservative and operative management options for the treatment of comminuted proximal Humerus fractures in the elderly (>65years old). A single payer perspective was taken, with a ten year time horizon. Model inputs including clinical outcome probabilities, and health utility values, were derived from a review of the literature. Treatment costs were obtained from the local healthcare system and regional healthcare authority. Threshold sensitivity analyses were performed to evaluate the impact of implant costs, complication rates, and patient outcomes on the cost-effectiveness of the treatment strategies.

Compared to non-operative management, patients receiving Hemiarthroplasty had an incremental increase in costs of \$8,464.78, with a moderate improvement in Quality Adjusted Life-Years (QALYs) of 0.08. ORIF had an incremental increase in costs of \$8,538.29 over conservative management, and did not result in any increase in QALYs. Lastly, RTSA had an incremental cost of \$10,683.46 and resulted in 0.15 QALYs gained compared to non-operative management (Table 1). When assessing overall cost effectiveness, ORIF was dominated by the other treatment strategies, Hemiarthroplasty resulted in an incremental cost-effectiveness ratio (ICER) of \$100,946.33/QALY gained and RTSA resulted in an ICER of \$37,924.64/QALY gained. Whether a threshold of \$50,000 or \$100,000/QALY gained is used, RTSA is a cost-effective option while ORIF and Hemiarthroplasty are not (Figure 1). Sensitivity analysis revealed that hemiarthroplasty could only be made a cost effective option as the index treatment and implant costs were reduced by 35%. Model results were robust for RTSA, as long as index treatment and implant costs remained below \$15,758.99.

The cost-effectiveness of treatment options for comminuted, displaced three and four part proximal Humerus fractures in the elderly is dependent on the cost of the implant, and the associated complications relative to conservative management. Our findings show that, compared to conservative management, hemiarthroplasty and ORIF are not cost-effective approaches, while RTSA may result in improved outcomes with an acceptable increase in up-front and one-year treatment costs.

### **121. FIXATION FAILURE AND TIME TO RE-OPERATION AFTER INTERNAL FIXATION OF YOUNG FEMORAL NECK FRACTURES: A POPULATION-BASED STUDY IN BRITISH COLUMBIA, CANADA**

**Presenter: David J. Stockton, BC**

L. O'Hara, MD, N. O'Hara, MD, K. Lefaivre, BC, P. O'Brien, BC, G. Slobogean, MD

Young femoral neck fracture patients treated with internal fixation frequently experience re-operations for painful hardware, femoral head avascular necrosis, and femoral neck nonunion. Conversion to total hip arthroplasty (THA) is a definitive marker of failed joint preservation and the need for salvage surgery. The primary aim of this study was to determine the failure rate and time to re-operation events following internal fixation of young femoral neck fractures.

This study used the linked administrative databases managed by Population Data BC to create a retrospective cohort of all British Columbia residents who underwent internal fixation for a femoral neck fracture during 1985 – 2009. This ensured all patients would have a minimum of five years of follow-up, based on the most current data available for analysis. All included patients were between the ages of 18-50. Exclusion criteria were concomitant pelvis or acetabular fracture; ipsilateral femur shaft fractures were included. Univariate distributions were reported for demographic variables such as age, gender, and median time to re-operation. Bivariate distributions were reported by type of operation, with a particular focus on time to hardware removal, proximal femoral osteotomy, and total hip arthroplasty (THA). All statistical analyses were conducted using SAS 9.4 (SAS Institute).

One thousand nine hundred and eighty-eight patients with complete data met eligibility criteria. Patient injury demographics indicate that the population was primarily male (67%) with a median age of 41 years (IQR: 32 – 47). Five hundred and forty-nine patients (28%) experienced at least one re-operation at a median of 21 months from injury (IQR: 9 – 49). The majority of first re-operations were hardware removals (n=246, 12%), conversion to total hip arthroplasty (n=146, 7%), and revision nonunion surgeries (n=57, 3%). Among the 109 patients that required a second re-operation, the median time to their third fracture-related surgery was 15 months following their first revision (IQR: 6 – 39). The overall median time from injury to total hip arthroplasty was 36 months from initial fracture (n=196, IQR: 17 – 90).

Based on this large population-based cohort study, approximately 10% of young femoral neck fracture patients treated with internal fixation will require conversion to THA within a median of three years from their injury. When including other fracture-related indications for re-operations, over 20% of these patients will undergo at least one re-operation. These results highlight the common need for re-operation after a young femoral neck fracture and patients must be counseled accordingly. Treatment for this difficult fracture requires more research to improve results.

### **COA Sports Medicine**

### **122. ANATOMIC ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION - A PROSPECTIVE EVALUATION USING THREE-DIMENSIONAL MAGNETIC RESONANCE IMAGING**

**Presenter: Adam Hart, QC**

T. Sivakumaran, QC, M. Burman, QC, T. Powell, QC, P. Martineau, QC

The recent emphasis on anatomic reconstruction of the anterior cruciate ligament (ACL) is well supported by clinical and biomechanical research. Unfortunately, the location of the native femoral footprint can be difficult or

even impossible to see at the time of surgery. Most surgeons therefore rely on anatomic landmarks, custom drill guides, or general rules-of-thumb to guide femoral tunnel placement; however, the accuracy of these techniques to reconstruct each patient's native anatomy is poorly understood. The objective of this study was to use a previously described isotropic magnetic resonance sequence (3D MRI) to image patients with torn ACLs before and after reconstruction and thereby assess the accuracy of graft position on the femoral condyle in comparison to each patient's native ACL footprint.

Forty-one patients with unilateral ACL tears were prospectively recruited into our study. Each patient underwent a 3D MRI of both the injured and uninjured knees before surgery. The contralateral (uninjured) knee scan was used to define the patient's native footprint. Patients then underwent ACL reconstruction with hamstring autograft by one of four experienced fellowship-trained sports orthopaedic surgeons. The injured knee was reimaged after surgery. The location and percent overlap of the reconstructed femoral footprint was compared to the patient's native footprint.

The centre of the native ACL femoral footprint was a mean of 16.4 +/- 4.6 mm distal and 5.3 +/- 2.9 mm anterior to the apex of the deep cartilage. The position of the reconstructed graft was significantly different, with mean distance of 10.4 +/- 2.7mm distal ( $P<0.0001$ ) and 7.7 +/- 3.1 mm anterior ( $P=0.001$ ). The mean distance between the centre of the graft and the centre of the native ACL femoral footprint (error distance) was 5.7 +/- 3.6 mm. Comparing error distances amongst the four surgeons demonstrated no significant difference using the Kruskal-Wallis one-way ANOVA ( $P=0.78$ ). On average, 21% of the graft was within the native ACL femoral footprint. Of the 41 patients, 16 (39%) had the graft placed entirely outside the native ACL footprint.

Despite contemporary techniques and a concerted effort to perform anatomic ACL reconstructions by four experienced sports orthopaedic surgeons, the position of the femoral footprint was significantly different between the native and reconstructed ligaments. Furthermore, each of the four surgeons uses a different technique but all had comparable errors in their tunnel placements. In order to achieve a truly anatomic reconstruction, surgeons may consider using a pre-operative 3D MRI, which enables excellent visualisation of the ACL's native anatomy and could potentially be used as a roadmap to guide anatomic tunnel placement.

### **123. A RANDOMISED CLINICAL TRIAL COMPARING PATELLAR TENDON, HAMSTRING TENDON AND DOUBLE-BUNDLE ACL RECONSTRUCTIONS: PATIENT-REPORTED CLINICAL OUTCOMES AT FIVE-YEAR FOLLOW-UP**

**Presenter: Nicholas G.H. Mohtadi, AB**

D. Chan, AB, R. Barber, AB

This prospective, double-blind RCT compares reconstruction for isolated ACL deficiency using patellar tendon, quadruple hamstring or double-bundle hamstring tendon grafts, by measuring disease-specific quality-of-life outcome at five-years post-operative.

Patients ( $n=330$ ; 183M/147F; 14-50yrs) were randomised to an anatomic ACL autograft reconstruction technique (110/group): 1) Patellar Tendon (PT; mean 28.7yrs), 2) Quadruple-stranded Hamstring Tendon (HT; mean 28.5yrs), or 3) Double-Bundle using hamstring tendons (DB; mean 28.3yrs). Computer-generated varied block randomisation occurred intra-operatively. Patients and an independent trained examiner were blinded to treatment allocation. Outcomes were measured at baseline, three, six months and one, two, five years. Two-year results were previously reported. Primary: Anterior Cruciate Ligament Quality-of-Life (ACL-QOL). Secondary: IKDC subjective score and objective grades, pivot shift, kneeling pain, Tegner activity, Cincinnati Occupational Scale. Proportions of complete re-ruptures, partial re-ruptures and combined total traumatic re-injuries were compared. Radiographs were taken at baseline, two and five years; analysis is ongoing. An analysis of variance for repeated measures using Bonferonni post-hoc was used for mean outcomes; Chi-square analyses for categorical data. A 5% significance level was used.

Three-hundred-and-fifteen patients (95%) completed five-year follow-up; four withdrew, 11 were lost-to-follow-up. Baseline characteristics between groups were not different. ACL-QOL scores increased from baseline for all groups ( $p=0.000$ ). Mean five-year ACL-QOL scores were not different ( $p=0.548$ ): PT=82.5 (SD 17.9, 95%CI

79.0–86.0); HT=83.9 (SD 18.2, 95%CI 80.3–87.4); DB=81.1 (SD 19.3, 95%CI 77.4–84.8). At five-years, the proportion of patients with pivot shift grade  $\geq$  two were not different ( $p=0.106$ ; PT=11/98 (11%); HT=16/99 (16%); DB=23/103 (22%)). Five-year secondary outcomes were not different between groups: IKDC subjective ( $p=0.770$ ): PT=83.9 (SD 12.9, 95%CI 81.4–86.5); HT=85.2 (SD 13, 95%CI 82.7–87.7); DB=84.3 (SD 13.4, 95%CI 81.7–86.9); IKDC Normal/Nearly Normal knees ( $p=0.093$ ): PT=85/98 (87%); HT=82/99 (81%); DB=75/103 (76%); Tegner activity ( $p=0.872$ ); Cincinnati Scores ( $p=0.813$ ). Kneeling pain remained more common in the PT group (PT=10/98; HT 4/98; DB 2/101;  $p=0.029$ ). More complete traumatic graft ruptures occurred in the HT and DB groups (PT=4/103; HT=11/105; DB=11/107;  $p=0.145$ ). Revision ACL reconstruction was performed on 22 patients. An additional 11 patients had partial graft re-ruptures (PT=0; HT=5; DB=6). Less traumatic re-injuries occurred in the PT group (PT=4; HT=16; DB=17,  $p=0.010$ ). Four patients had additional surgery to the index knee, excluding revision, between two and five years.

At five-years, there was no difference in disease-specific quality-of-life outcome between the ACL reconstructions, but significantly more traumatic graft re-injuries in the HT and DB than the PT group.

#### **124. MEDIAL PATELLOFEMORAL LIGAMENT RECONSTRUCTION REDUCES RADIOGRAPHIC MEASURES OF PATELLA ALTA IN ADULT PATIENTS**

**Presenter: Jarrett M. Woodmass, AB**

N. Johnson, OK, R. Cates, MN, A. Krych, MN, M. Start, MN, D. Dahm, MN

Patellar height has long been considered a risk factor for patellofemoral instability with as many as 58% of patients meeting criteria for patella alta. However, recent paediatric literature has demonstrated a reduction in radiographic patellar height measurements following medial patellofemoral ligament (MPFL) reconstruction. The objective of this study is to assess the mean change in patellar height and the percentage of patients with patellar height ratios reduced to within normal limits following MPFL reconstruction in skeletally mature patients.

Adult patients undergoing primary MPFL reconstruction between 2005 and 2013 for recurrent lateral patellar instability were identified. Pre-operative and post-operative (within one year of surgery) lateral knee radiographs were assessed for patellar height indices including Caton-Deschamps, Blackburn-Peel, and Insall-Salvati ratios. The change in patellar height and the number of patients reduced from an abnormal to normal patellar height ratios were assessed following MPFL reconstruction.

Overall, 32 adult patients were included in the study with a mean age of 25.7 (range, 18 to 55). There were 21 females (66%) and 11 males (34%). Insall-Salvati, Blackburn-Peel, and Caton-Deschamps ratios all demonstrated significant reductions in patellar height between pre- and post-operative lateral knee radiographs ( $p<0.001$ ). All three indices showed a reduction in the number of patients meeting the criteria for patella alta following MPFL reconstruction. Over two thirds of patients with an abnormal pre-operative Caton Deschamps ratio reduced to within normal limits post-operatively.

Medial patellofemoral ligament reconstruction in adult patients provided consistent reductions in patellar height measurements. This was most evident using the Caton-Deschamps ratio where 67% of patients with pre-operative patella alta ( $CD > 1.2$ ) were reduced to within the normal reference range following MPFL reconstruction. A reduction in patellar height should be expected by surgeons treating patellofemoral instability and this knowledge should be considered when evaluating the need for more invasive distalisation procedures.

#### **125. A PROSPECTIVE COHORT STUDY ASSESSING THE DEVELOPMENT OF CAM FEMORO-ACETABULAR IMPINGEMENT MORPHOLOGY**

**Presenter: Paul Jamieson, ON**

S. Carsen, ON, K. Rakhra, ON, K. Highmore, ON, L. Ward, R. Willis, ON, P.E. Beaulé, ON

Femoro-Acetabular Impingement (FAI) is an important cause of adolescent hip pain and has been postulated to be the major cause of hip osteoarthritis in adults. Despite this, there is a paucity of literature surrounding its etiology. A 2014 cross-sectional study by Carsen et al. found that of 44 asymptomatic paediatric patients, 14% of

post-physeal closure patients had evidence of cam morphology on MRI whereas 0% of pre-physeal closure patients had evidence of cam morphology. Moreover, patients with evidence of cam morphology had significantly higher daily activity scores, further supporting the theory that physical activity during the critical years of physeal growth and closure may be a risk factor for development of FAI. The purpose of this study was to prospectively follow the cohort of pre-physeal closure patients through skeletal maturity to identify the incidence of development of FAI morphology. The secondary objective of this study is to quantify activity level as a risk factor for the development of FAI morphology.

This is a prospective cohort study of all patients with open physes from the initial cross-sectional study. These were asymptomatic volunteers with no prior hip pathology and an average age of 10.5 years old. Patients were followed for six years to allow for skeletal maturation after which a non-contrast MRI of both hips was performed according to our institutions FAI MRI protocol. Alpha angles were measured at the three (anterior head-neck junction) and 1:30 o'clock (antero-superior head-neck junction) positions. Cam morphology was defined as an alpha angle  $\geq 50.5^\circ$ . Activity scores were measured using the Hospital for Special Surgery Paediatric Functional Activity Brief Scale (HSS Pedi-FABS).

Twenty-three patients were enrolled in the study, 11 males and 12 females. Three patients refused participation and were excluded from analysis. Twenty patients (nine males, mean age 17.1 years; 11 females, mean age 15.5 years) were included for analysis. The mean alpha angle at the three o'clock position was  $38.11^\circ$  and  $47.5^\circ$  at the initial and final MRI, respectively. The mean alpha angle at the 1:30 o'clock position was  $45.2^\circ$  and  $48.2^\circ$  at the initial and final MRI, respectively. FAI cam morphology was identified in at least one hip in 8/20 (40%) patients (five males; three females). Mean HSS Pedi-FABS score was higher in patients with cam deformity (19/30) than those without (13/30).

This study is the first of its kind to prospectively identify the incidence of development of FAI cam morphology. The incidence of FAI morphology was 40% through skeletal maturity and more common in males (55.6%) than females (27.3%). FAI morphology was associated with higher activity scores, supporting the theory that activity level during physeal closure is an important risk factor for the development of cam FAI morphology. This study helps to better understand the causation of FAI morphology and may guide the development of interventions to modify its incidence.

## **127. PROTECTIVE AND ADVERSE MUSCLE ACTIVATION STRATEGIES AFTER ACL-INJURY DURING A WEIGHT-BEARING FORCE CONTROL TASK**

**Presenter: Daniel L. Benoit, ON**

T. Alkjaer, Denmark, K. Smale, ON, E. Simonsen, Denmark, M. Krogsgaard, Denmark, T. Flaxman, ON

Anterior cruciate ligament (ACL) injury results in a loss of mechanical knee joint stability. To maintain stability, the neuromuscular system must integrate activity of all muscles that cross the knee joint and create a joint moment that effectively opposes the external load. Differences in muscle activation patterns and movement dynamics are commonly identified between ACL deficient (ACLD) and uninjured controls (CON); however, it remains unclear how and which of these differences help to improve or reduce knee joint stability. The purpose of this study was to quantify how differences in muscle activation after an ACL injury are interrelated with changes in internal net joint moments.

Twenty-four ACLD adults (11 females) and 24 matched CON completed a standing force matching protocol. Participants were required to isometrically modulate ground reaction forces to elicit various combinations of sagittal, frontal and transverse plane internal joint moments. Partial least squares regressions [1] determined which internal moment(s) predicted the activation of 10 lower limb muscles for each group.

Compared to CON, ACLD demonstrated stronger relationships between (1) rectus femoris and knee extension, (2) semitendinosus and knee flexion, and (3) gastrocnemius and knee flexion moments. ACLD had weaker relationships between (3) biceps femoris and knee flexion, (4) gastrocnemius and external knee rotation, and (5) gluteus medius and hip abduction moments compared to CON.

The relationship between individual muscle activation and internal joint moments differ between ACL and CON. We suggest neuromuscular adaptations after ACL injury improve sagittal plane stability, but reduce stability during knee abduction and rotational external loads. Considering mechanisms of ACL injury and episodes of giving way is likely associated with knee abduction and rotation [2], future works should focus on the neuromuscular contribution of the hamstring and gastrocnemius muscles to rotational stability and the hip abductor's role in modulating knee's frontal plane loads. Results can contribute to the development of injury rehabilitative/ preventative exercise interventions and provide insight into mechanisms of knee joint stability. References: [1] Haenlein & Kaplan. (2004). *Understand Stats*; 3:283-97. [2] Besier et al. (2001). *Med Sci Sport Exer*; 33:1168-75.

## **128. HIP ARTHROSCOPY POST OPERATIVE NEUROPATHY**

**Presenter: Basha Reda, NS**

I. Wong, NS

As a rapidly growing new technique hip arthroscopy has a unique set of complication. One of the most commonly reported complications is neuropraxia related to the use of traction during the procedure. The reported rate varies between 2.6 to 20 %. This variability is likely because the patients are not directly asked about it or they think its not related to their recent procedure. The purpose of our review is to investigate the rate of post-operative neuropraxia in a high-volumetertiary canter. We hypothesize that this complication is under-diagnosed and it is higher than what was reported in the literature. The secondary objective is to assess factors that contribute to the development of this complication and make recommendations based on that. We are also studying the effect of post operative neuropraxia on the functional outcome scores for our patient population. To our knowledge this is the largest study looking at the prevalence of patient reported neuropraxia after hip arthroscopy.

Ethics approval was granted by our institutional board. All patients that have previously undergone hip arthroscopy at a Capital Health District Authority facility performed by the senior author (IW) between 2013 and 2016 were contacted the study. Exclusion criteria for the study are those patients who decline participation and those who were not able to be reached by the phone. Telephone survey and chart review were done for each participant. Also iHOT patient reported outcome score was collected for each patient.

A total of 221 completed surveys. Overall, 37% (82 )of patients reported having experienced some form numbness following surgery. The two most common areas of numbness reported were groin (40.2%) and anterolateral (40.2%) area of the upper leg. This was followed by foot numbness (29.3%) and other areas (13.4%). Approximately (23%) of those with post-operative numbness reported having numbness in more than one area. About 43% (35 of 82) of the patients reported resolution at six weeks post-operatively and the majority of numbness was reported to have completely resolved by six months 68% (56 of 82).

Post-operative neuropathy is more common than previously reported and likely under-diagnosed post hip arthroscopy. Further research to specifically define and study this complication is required in order to identify patient and procedure related factors that could be modified to lower the rate of this complication.

## **129. COMPLICATION, RE-OPERATION, AND READMISSION RATES FOLLOWING ROTATOR CUFF REPAIR: A COMPARATIVE STUDY OF OPEN VS. ARTHROSCOPIC ROTATOR CUFF REPAIR**

**Presenter: Timothy Leroux, ON**

B. Basques, IL, R. Frank, IL, J. Griffin, IL, N. Verma, IL, A. Romeo, IL

Although arthroscopic rotator cuff repair (RCR) has gained in popularity, comparative studies have failed to demonstrate a clinical benefit of arthroscopic over open RCR. In the present study, we used a large population cohort to compare the 90-day complication rate, 30-day and 90-day readmission rates, and overall and procedure-specific re-operation rates between patients undergoing arthroscopic or open RCR in the United States (US).

A retrospective analysis of private payer data was performed to identify open and arthroscopic RCR procedures performed from 2007 through 2014. Multivariate logistic regression was used to compare groups in terms of post-operative complications within 90 days, readmission within 30 and 90 days, and overall and procedure-specific re-operation rates at various time points. Multivariate regression controlled for differences in baseline patient characteristics, and results were reported as odds ratios (OR) with alpha set at 0.05.

A total of 45,181 patients were identified, of which 14,749 (33.6%) underwent open RCR and 30,432 (67.4%) underwent arthroscopic RCR. Since 2007, the annual utilisation of arthroscopic RCR has increased significantly ( $p < 0.001$ ). As compared to arthroscopic RCR, there were increased rates of multiple complications within 90 days following open RCR, including deep vein thrombosis (DVT)/pulmonary embolus (PE) (OR 1.2,  $p = 0.006$ ), nerve injury (OR 1.6,  $p = 0.024$ ), surgical site infection (OR 3.7,  $p < 0.001$ ), wound dehiscence (OR 3.3,  $p < 0.001$ ), and hematoma (OR 2.0,  $p < 0.001$ ). In addition, open RCR had significantly increased rates of 30-day (OR 1.7,  $p < 0.001$ ) and 90-day readmission (OR 1.4,  $p < 0.001$ ), and reoperation at 30 days (OR 1.3,  $p < 0.001$ ), 90 days (OR 1.5,  $p < 0.001$ ), six months (OR 1.5,  $p < 0.001$ ), and one year (OR 1.4,  $p < 0.001$ ) as compared to arthroscopic RCR.

The odds of post-operative complications, readmissions, and re-operations were significantly greater following open RCR as compared to arthroscopic RCR.

### **130. TIMED AND TRIPLE HOP TESTS ACCURATELY INDICATE FUNCTIONAL PERFORMANCE AND DISEASE-SPECIFIC QUALITY OF LIFE TWO YEARS AFTER ACL RECONSTRUCTION**

**Presenter: Laurie A. Hiemstra, AB**

G. Buchko, AB, M. Lafave, AB, S. Kerlake, AB, M.S. Heard, AB

The aim of an anterior cruciate ligament (ACL) reconstruction is to regain functional stability of the knee following ACL injury, ideally allowing patients to return to their pre-injury level of activity. The purpose of this study was to assess functional and patient-reported outcomes two years after ACL reconstruction.

A prospective cohort study design ( $n = 1241$ ) was used to gather functional performance data and disease-specific quality of life outcomes. A battery of functional tests was performed including single-leg balance on a BOSU ball, single-leg drop landing, and four single-leg hop tests. The hop tests provided a comparative assessment of limb-to-limb function including a single hop for distance, a six metre timed hop, a triple hop for distance, and a triple crossover hop. Patients completed the anterior cruciate ligament quality of life questionnaire (ACL-QOL) at the two year post-operative appointment. Descriptive and demographic data were collected for all patients. A paired t-test was performed to determine the difference in function of the operative and non-operative limbs two year post-operatively on the functional tests. A Pearson  $r$  correlation coefficient was employed to determine the relationship between the battery of functional tests and the ACL-QOL scores.

One thousand two hundred and forty-one patients underwent primary anatomic hamstring ACL reconstruction between January 2010 and December 2013. 964/1241 patients (77.7%) completed two year follow-up. Statistically significant differences ( $p < 0.002$ ) were evident between the operative and non-operative limb six metre timed hop, triple hop for distance and triple crossover hop tests at 24 months post-operative. There was no significant difference for limb performance on the single hop test. Correlations (two-tailed) were significant at the 0.01 level for: operative limb single leg BOSU balance and operative limb six metre timed hop, triple hop for distance and triple crossover hop, as well as operative single leg BOSU balance and ACL-QOL score, at 24 months post-operative. Correlations (two-tailed) were significant at the 0.05 level for: triple hop for distance and six metre timed hop and triple crossover hop, as well as triple hop for distance and ACL-QOL score, at 24 months post-operatively.

The non-operative limb outperformed the operative limb for the six metre timed, triple hop for distance and triple crossover hop tests 24 months following ACL reconstruction. The single hop for distance did not demonstrate any significant functional difference between limbs, and requires further investigation as a measure for assessing outcomes following ACL reconstruction. The patient-reported disease-specific outcome measure

(ACL-QOL) was strongly correlated to the patient's ability to perform single limb balance and hop tests, indicating that the ACL-QOL score accurately represented function two years after ACL reconstruction.

### **131. A TRAFFIC LIGHT GRADING SYSTEM OF HIP DYSPLASIA TO PREDICT THE SUCCESS OF ARTHROSCOPIC HIP SURGERY**

**Presenter: George Grammatopoulos, ON**

O. Davies, UK, A. El-Bakoury, UK, R. Gill, UK, T. Pollard, UK, T. Andrade, UK

The role of hip arthroscopy in the setting of dysplasia is controversial. Identifying parameters that increase the chance of joint preservation following arthroscopy in dysplastic hips, would aid decision-making. The aim of this study was to define the seven year joint preservation following hip arthroscopy in a cohort of dysplastic hips and identify anatomical and intra-operative features that could predict success of hip preservation with arthroscopic surgery allowing formulation of an evidence based classification.

This is a retrospective cohort series from a single, tertiary referral centre for hip arthroscopy. We reviewed our database of 377 hip arthroscopies performed between 2008-13 (ensuring a minimum two-year follow-up) and identified 112 hips (108 patients, 79 females) with features of dysplasia [acetabular index (AI)  $> 10^\circ$  and/or centre-edge angle (CEA)  $< 25^\circ$ ], which formed this study's cohort. Patients with joint space  $< 2\text{mm}$  on radiographs were excluded. Clinical, radiological and operative findings (presence and extent of articular wear using UCL grading system, labral pathology) and type of procedure performed (labral repair or debridement, osteochondroplasty) were reviewed. Radiographic evaluations of the operated hip (acetabular index, centre-edge angle, extrusion index) were performed using a validated (HipMorf) software from Antero-Posterior Pelvic radiographs. Outcome was determined from hospital records. As the extent of intra-articular wear and dysplasia have been shown to be interlinked we defined AI and CEA factored (AIf and CEAF respectively) for articular wear as follows:  $AIf = AI \times (\text{number of UCL wear zones} + 1)$ ,  $CEAF = CEA \times (\text{number of UCL zones} + 1)$ . In order to identify the zones with the lowest and highest incidence of failure to preserve the hip, a 2x2 contingency table analysis was performed for every combination of AIf and CEAF. A contour plot of the resulting probability values allowed for the location of the zones with the lowest and highest incidence of failure to preserve the hip respectively. Statistical analysis was performed with Matlab and SPSS (version 15, IBM).

The mean age of the study cohort was 41 years old. The mean AI was  $7.8^\circ$  and the mean CEA was  $18.0^\circ$ . At a mean follow-up of 4.4 years, 33 hips had failed requiring a hip arthroplasty. The seven year joint survival was 68%. The optimal zone with the greatest chance of joint preservation (odds ratio: 10, Overall, the seven year hip survival appears inferior to reports with Femoro-Acetabular Impingement. Hip arthroscopy is associated with excellent chance of hip preservation in mild (green light) dysplasia (AI  $< 15^\circ$  & CEA:  $15 - 25^\circ$ ) and no articular wear. Hip arthroscopy should not be performed in cases with severe (red light) dysplasia (AI  $> 20^\circ$  & CEA  $< 10^\circ$ ).

Overall, the seven-year hip survival appears inferior to reports with Femoro-Acetabular Impingement. Hip arthroscopy is associated with excellent chance of hip preservation in mild (green light) dysplasia (AI  $< 15^\circ$  & CEA:  $15 - 25^\circ$ ) and no articular wear. Hip arthroscopy should not be performed in cases with severe (red light) dysplasia (AI  $> 20^\circ$  & CEA  $< 10^\circ$ ).