1 - Gait Function after Total Knee Arthroplasty Remains Distinct from Asymptomatic
Jereme Outerleys, NS; Michael Dunbar, NS; Glen Richardson, NS; Cheryl Kozey, NS; Janie Wilson, NS

Purpose: Total knee arthroplasty (TKA) has been shown to improve knee joint function during gait post-operatively. However, there is considerable patient to patient variability, with most gait mechanics metrics not reaching asymptomatic levels. To understand how to target functional improvements with TKA, it is important to identify an optimal set of functional metrics that remain deficient post-TKA. The purpose of this study was to identify which combination of knee joint kinematics and kinetics during gait best discriminate pre-operative gait from postoperative gait, as well as post-operative from asymptomatic.

Method: Seventy-three patients scheduled to receive a TKA for severe knee osteoarthritis underwent 3D gait analysis 1 week before and 1 year after surgery. Sixty asymptomatic individuals also underwent analysis. Eleven discrete gait parameters were extracted from the gait kinematic and kinetic waveforms, as previously defined (Astephen et al., J Orthop Res., 2008). Stepwise linear discriminant analyses were used to determine the sets of parameters that optimally separated pre-operative from post-operative gait, and post-operative from asymptomatic gait. Cross-validation was used to quantify group classification error.

Results: Knee flexion angle range, knee adduction moment first peak, and gait velocity were included in the optimal discriminant function between the pre- and post-operative groups (P<0.05), with relatively equal standardized canonical coefficients (0.567, -0.501, 0.565 respectively), and a total classification rate of 74%. A number of metrics were included in the discriminant function to optimally separate post-operative and asymptomatic gait function, including the knee flexion angle range, peak stance knee flexion angle, minimum late stance knee extension moment, minimum mid-stance knee adduction moment, and peak knee internal rotation moment (P<0.05). The mid-stance knee adduction moment had the largest standardized canonical coefficients in the function, and 89.5% of cases were correctly classified.

Conclusion: Separation of pre and post-operative gait patterns included only three parameters, suggesting that current standard of care TKA significantly improves only walking velocity, knee flexion...
angle range, and the peak value of the knee adduction moment. A number of gait metrics, which were included in the discriminant function between post-operative and asymptomatic gait, could benefit from further improvement either through rehabilitation or design. With almost 90% classification, separation of post-operative gait function from asymptomatic levels is significant. The consolidation of knee joint function during gait into single, discrete discriminant scores allows for an efficient summary representation of patient-specific (or implant-specific) improvement in gait function from TKA surgery.

2 - Post-operative Muscle Activity during a Stairs Ascent Task in Patients with Medial Pivot Implants
Mario Lamontagne, ON; Erik Kowalski, ON; Geoffrey Dervin, ON

Purpose: The purpose of this study was to compare lower limb muscle activity in patients who underwent a total knee arthroplasty (TKA) with a medial pivot (MP) implant to healthy controls (CTRL) during a stair ascent task.

Method: Seven MP (age: 61.4±6.5 years, BMI: 30.0±4.7 kg/m2, 12.4±3.8 months post-surgery) patients who underwent a TKA performed using either a subvastus or medial parapatellar approach were age- and BMI-matched to seven healthy CTRL participants (age: 62.4±4.2 years, BMI: 26.3±2.7 kg/m2) for comparison in this study. Participants underwent electromyography (EMG) analysis while completing a three-step stairs ascent task. Portable wireless surface EMG probes were placed on the vastus lateralis (VL), rectus femoris (RF), vastus medialis (VM), biceps femoris (BF) and semimembranous (SM) muscles of both lower limbs. Peak linear envelope (peakLE) and total muscle activity (iEMG) were extrapolated and normalized to a maximal voluntary contraction. Nonparametric Kruskal Wallace ANOVA tests were used and Wilcoxon rank sum tests were used to identify where significant (p < 0.05) differences occurred.

Results: The operated limb had significantly lower iEMG in the VAL, RF and BF muscles, and significantly lower peakLE in the SM muscle compared to the non-operated limb. The operated-limb of the MP group had significantly lower iEMG in the VAL and BF muscles, and significantly lower peakLE in the VAL, RF and SM muscles compared to the CTRL group. The non-operated limb in the MP group had significantly larger peakLE and iEMG in the RF muscle compared to the CTRL group.

Conclusion: Differences in muscle activity between the operated and non-operated limbs in TKA patients with a MP implant demonstrates a compensatory strategy to reduce loading on the operated limb by relying on the non-operated limb. This same strategy has been reported in other studies investigating other functional tasks. This reliance on the non-operated limb resulted by having greater peakLE and iEMG in the RF muscle compared to the healthy CTRLs. These differences between limbs could also result from many years of muscle adaptation waiting to receive a knee replacement. In conclusion, TKA patients exhibit discrepancies in muscle activity compared to healthy knees and differences between operated and non-operated limbs. Post-surgery rehabilitation should rely on unilateral strength exercises of the quadriceps and hamstrings muscles to reduce discrepancies to allow for a more balanced muscle activity between limbs.

3 - Post-operative Joint Mechanics during Stairs Ascent and Descent Tasks in Patients with Posterior Stabilized and Medial Pivot Implants
Mario Lamontagne, ON; Erik Kowalski, ON; Geoffrey Dervin, ON

**Purpose:** The purpose of this study was to compare lower limb joint mechanics in patients who underwent a total knee arthroplasty (TKA) with either a posterior stabilized (PS) or with a medial pivot (MP) implant to healthy controls (CTRL) during stair ascent and descent tasks.

**Method:** Six PS (age: 67.2±1.5 years, BMI: 31.0±3.2 kg/m²) and 11 MP (age: 62.3±6.0 years, BMI: 29.7±3.9 kg/m²) TKA patients matched to 10 healthy CTRL participants (age: 65.6±5.5 years, BMI: 27.2±5.0 kg/m²) were included in the study. TKA patients went through 3D motion analysis after unilateral TKA with either a MP (11.7±3.4 months post-surgery) or PS (10.1±3.4 months post-surgery) implant performed using either a subvastus or medial parapatellar approach. Kinematic and kinetic data was collected using a 10-camera Vicon and two portable Kistler force plates placed on the first and second stair of a three-step staircase. Nonparametric Kruskal Wallace ANOVA tests were used and Wilcoxon rank sum tests were used to identify where significant (p < 0.05) differences occurred.

**Results:** When comparing both stair tasks, stair ascent showed a larger number of significant differences in kinematic and kinetic variables than stair descent. Peak knee extension was significantly (p < 0.05) greater in both TKA groups compared to the CTRL during stair descent, whereas only the PS group had significantly (p = 0.02) greater knee extension angle than the CTRL during stair ascent. The PS group had a significantly (p = 0.01) lower peak knee extension moment than the CTRL group during both tasks and compared to the MP group during stairs ascent. During stair ascent, the MP group had significantly (p = 0.02) larger peak hip extension moments than both PS and CTRL group.

**Conclusion:** Greater knee extension angles in TKA groups at foot strike during stair tasks support the notion that TKA groups exhibit stiff knee during stance to reduce or avoid shear displacement on the operated knee. This could also result from many years of muscle adaptation waiting to receive a knee replacement. Reduced peak knee extension moment in the PS group during stairs tasks showed a quadriceps deficiency that could increase the risk of revision or of other joint replacement on the contralateral side or ipsilateral hip. MP group reproduced similar joint loading patterns as the CTRLs which may reduce their risk of revision. In conclusion, TKA patients continue to exhibit discrepancies from healthy knee mechanics during stair ascent and descent. Further research examining muscle function especially during stair ascent is warranted.

4 - Synovial Mesenchymal Progenitor Cell Surface Markers in vivo as Indicators for Differentiation Potential

Asmaa Affan, AB; Nedaa Aljezani, AB; Pamela Railton, AB; James Powell, AB; Roman Krawetz, AB

**Purpose:** There is currently no cure for osteoarthritis (OA), although there are ways to manage it, but most require quite invasive surgeries. There is a resident mesenchymal progenitor cell (MPC) population within the synovial membrane of the joint that have the ability to differentiate into bone, fat, and cartilage. We hypothesize that in vivo and in vitro cell surface marker expression comparisons of the MPCs can determine which population has the highest chondrogenic capacity and is best suited for future clinical trials.
**Method:** Method optimization protocol: Synovial biopsies (2 or 5mm) were obtained from patients undergoing surgery. The biopsies were digested in either collagenase type I, IA, IV or II at a concentration of 0.5 or 1.0 mg/mL. Digestion was conducted at 37°C for 30, 60, 90 or 120 min. To assay for the number of MPCs obtained, the cell suspension was stained with CD90 (a synovial MPC marker) and magnetically purified. The purified cells were then assayed by flow cytometry (Co-stained with a live/dead cell marker, BV510) or bright-field microscopy. Study protocol: Synovial tissues were digested in type IV collagenase for two hours to obtain a single cell suspension. The cells were subsequently stained with mesenchymal stem cell markers, including CD 90, CD 271, CD 44, CD73, and CD105, a macrophage marker, CD68. The macrophages were excluded and the remaining cells were index sorted into 96-well plates. The cells were expanded, and underwent 21-day chondrogenic, adipogenic, and osteogenic differentiation. Differentiation was assayed using RT-qPCR and histological methods. Additionally, the cells were re-analyzed for marker expression after culturing.

**Results:** Optimization: Synovial biopsies of 5mm produced a greater number of live CD90+ cells than 2mm biopsies. It was observed that type IV collagenase at 1mg/ML treatment for 120 min (hip) and 90 min (knee) obtained the greatest number of CD90+ MPCs from the synovium. Results: A single cell was isolated from an OA hip biopsy and was positive for the markers CD90, CD44, CD73, and negative for the markers CD68, CD271, CD105. Following differentiation, PCR analysis suggested that the cell line was able to differentiate into chondrocytes and adipocytes, but not osteoblasts. Histology data agreed with the PCR data with the adipocytes and chondrocytes having positive staining, whereas the osteoblasts were negative. FACS analysis following proliferation showed that the expression in vivo versus in vitro was the same except CD105 that became positive after proliferation in vitro.

**Conclusion:** MPCs express cell surface markers that provide information as to populations have the best cartilage regeneration abilities. By determining the properties of the MPCs in OA hips that allow for better chondrogenic differentiation abilities in vitro, selecting the optimal cells for regenerating cartilage can be done more efficiently for novel cell therapies for OA.

5 - Radiostereometric Analysis Using Clinical Radiographic Views: Measuring Total Hip Cup Position and Wear

Matthew G Teeter, ON; Kimberley Lam, ON; James Howard, ON; Brent Lanting, ON; Xunhua Yuan, ON

**Purpose:** Radiostereometric analysis (RSA) has become the gold standard technique for measuring implant migration and wear following joint replacement due to its high measurement precision and accuracy. However, RSA is conventionally performed using two oblique radiographic views with the presence of a calibration cage. Thus, a second set of radiographs must be acquired for clinical interpretation, for example anterior-posterior and cross-table lateral views following total hip arthroplasty (THA). We propose a modification to the RSA setup for examining THA, in which RSA measurements are performed from anterior-posterior and lateral views, with the calibration cage images acquired separately from the patient images. The objective of the current study was to compare the accuracy and precision of the novel technique to the conventional technique using a phantom.

**Method:** X-ray cassette holders were developed to enable simultaneous acquisition of anterior-posterior and cross-table lateral radiographs with the patient in a supine position in the RSA suite. A
Sawbones phantom with total hip implant components was attached to a micrometer-driven stage. The femoral component was translated known distances relative to the acetabular cup in all planes, mimicking head penetration due to wear. Double RSA examinations were acquired for each increment using the traditional and novel radiograph orientations. Translations were measured from the radiographic images using RSA software. For both techniques, accuracy was calculated by comparing the measured translations to the known translation from the micrometer, and reported as the 95% confidence interval. Precision was measured by comparing the measured translations between the double exams, and reported as the standard deviation.

**Results:** Accuracy was greater for the conventional technique in the inferior-superior axis (p = 0.03), greater for the novel technique in the anterior-posterior axis (p = 0.01), and equivalent in the medial-lateral axis (p = 0.06). Overall accuracy for both the conventional and novel techniques was identical at ±0.022 mm. Precision was equivalent between both techniques for the medial-lateral (p = 0.68), inferior-superior (p = 0.14), and anterior-posterior axes (p = 0.86). Overall precision for the conventional technique was ±0.127 mm and for the novel technique was ±0.095 mm.

**Conclusion:** Utilizing standard clinical radiograph view angles within an RSA exam had no detrimental effect on wear measurement accuracy or precision. This reduces the barriers to implementing RSA imaging in routine follow-up of arthroplasty patients, potentially greatly increasing the numbers of patients that can have quantitative data on implant performance. Future applications can involve applying more clinically relevant radiograph view angles to RSA exams of the knee and shoulder.

**6 - In vitro Wear Simulation of Reverse Total Shoulder Arthroplasty Implants**

**G Daniel Langohr, ON; George S Athwal, ON; James A Johnson, ON; John B Medley, ON**

**Purpose:** Reverse total shoulder arthroplasty (RTSA) reverses the native glenohumeral joint. Simulator wear rates have been reported to range from 4 - 125 mm³/Mc using a variety of motion and loading conditions. The purpose of the present study was to assess the wear of non-crosslinked polyethylene RTSA cups using a custom wear simulation strategy that was developed, based in part, on the load magnitudes and directions found in cadaveric RTSA reconstructed shoulder testing. These simulator conditions were expected to extend the existing simulator wear database, to give wear in the same locations as occur in vivo, and to help assess whether simulator wear rates could be considered high enough to cause clinical risk associated with wear particle-induced osteolysis.

**Method:** A modified orbital bearing hip wear simulator produced adduction-abduction (30-97.5°) and flexion-extension (±22.5°). A transient load profile (914 N peak), similar to that found with in-vitro testing of RTSA reconstructed cadaveric shoulders, was applied at 1.13 Hz for 1.44 million cycles (Mc) to eight commercially available RTSA implants (DePuy XTEND, 38 mm). The lubricant was bovine calf serum diluted with PBS to a protein concentration of 30 g/L, with sodium hyaluronate (HA) (1.5 g/L) and an antibiotic-antimycotic (1%). Every 0.25 Mc, the specimens were cleaned and weighed.

**Results:** All cups showed signs of wear after the first 0.25 Mc, and exhibited a distinct line near the superior margin of the wear scar (which divided the inferior wear scar and a thinner superior polished region) as well as signs of inferior edge wear. The glenospheres all exhibited some light surface
scratching throughout the contact zone in the inferior quadrant. Surface staining of the glenospheres was present upon removal of the glenospheres after every 0.25 Mc, which was removed during ultrasonic cleaning. The wear rates of the humeral cups had considerable variation, with a range of 115-345 mm3/Mc, and a wear rate (avg ± std dev) of 201 ± 87 mm3/Mc.

**Conclusion:** The wear rate in the present simulator wear study is high compared with metal-polyethylene hips in the 1980’s, suggesting that the wear of RTSA implants may become a long term clinical problem, although it is important to note that there is little consensus regarding simulator conditions. None of the other studies incorporated HA in their lubricant composition, which had been shown to increase the wear rate in knee simulator testing. An earlier pilot study with a single implant used alpha calf serum rather than regular bovine calf serum and had a reduced but still substantial wear rate (~40 mm3/Mc). Thus, the higher wear of the present study might be a consequence of the lubricant. The inferiomedial cup edge had considerable wear in the present simulator testing, which corresponded to damage found in clinical retrievals. The use of highly crosslinked polyethylene would reduce wear, but this might also exacerbate damage due to scapular notching.

**7 - Finite Element Modelling of Reverse Total Shoulder Arthroplasty Fixation**

Josie Elwell, US; Ryan Willing, US

**Purpose:** Failure of reverse total shoulder arthroplasty (rTSA) due to loosening of the metaglene remains a concern. The metaglene is typically affixed to the glenoid via four peripheral bone screws, and the orientations of these screws can affect the stability of the metaglene. The purpose of this finite element analysis (FEA) study was to investigate whether screw orientations should be considered on a patient-specific basis to maximize early fixation.

**Method:** Three-dimensional geometries of four scapula specimens were obtained by segmenting from CT data in 3D Slicer. A metaglene and four rigidly attached 4.5 mm diameter, 18 mm long cylinders representing screws, were placed on each reamed glenoid. Each screw was placed at one of four orientations, 15° or 7.5° toward or away from the central axis of the metaglene face, while all others were held in the baseline (BL) configuration, where all screws were perpendicular to the metaglene face. Finite element models were created by meshing with linear tetrahedral elements. Material properties of titanium (E=113.8 GPa, v=0.34) were applied to the metaglene and screws. Cortical bone material properties were considered uniform (E=17.5 GPa, v=0.3) while cancellous bone material properties were non-uniform and mapped on an element-by-element basis using CT attenuation data. The scapula was fully constrained, and a 252 N superiorly oriented shear force was applied to the inferior portion of the metaglene. Contact was modelled at bone-implant and bone-screw interfaces. Displacements of the metaglene with respect to the glenoid were measured. The orientations of each screw that minimized in-plane displacement were used for specimen-specific (SS) configurations. A global (GL) configuration was also defined based on the averages of SS orientations. FE model-predicted metaglene displacements of the SS, GL, and BL screw configurations were compared using paired t-tests.

**Results:** The average in-plane metaglene displacements for the SS, GL, and BL configurations were 4.8 ± 1.2, 6.5 ± 3.7, and 5.3 ± 1.5 um, respectively. SS configurations significantly decreased displacements by
-0.4 ± 0.3 um (-8.5%, p = 0.024) when compared to BL, but the difference of -1.6 ± 3.1 um (25.3%, p = 0.187) was not significant when compared to the GL configuration.

**Conclusion:** In general, the SS configurations resulted in smaller metaglene displacements than the GL configurations, however the difference was not statistically significant. In one specimen, the GL configuration resulted in abnormally large displacements. These results indicate that, while on average, patient-specific orientations won’t yield significantly greater fixation than global configurations; non-patient-specific configurations can, in some cases, yield poor results. Therefore, to ensure optimal fixation for all patients, screw orientations should be considered on a patient-specific basis.

8 - The Effect of Glenosphere Size on Adduction and Abduction Range of Motion in Reverse Total Shoulder Arthroplasty

**Michael Griffiths, ON; G Daniel G Langohr, ON; George S Athwal, ON; James A Johnson, ON**

**Purpose:** There are a variety of sizes currently available for reverse total shoulder arthroplasty (RTSA) implant systems. Common sizing options include a smaller 36 to 38 mm or a larger 40 to 42 mm glenosphere, and are typically selected based on surgeon preference or patient size. Previous studies have only evaluated the abduction and adduction range of motion within a single plane of elevation, providing a limited view of the joint’s possible range of motion. The purpose of this study was to use computer modeling to evaluate the abduction and adduction range of motion across multiple planes of elevation for a range of glenosphere sizes.

**Method:** Computed tomography images of four cadaveric specimens (age: 54 ± 24 years) were used to obtain the osseous anatomy to be utilized in the model. Solid-body motion studies of the RTSA models were constructed with varying glenosphere diameters of 33, 36, 39, 42, and 45 mm in Solidworks (Dassault Systems, US). The implant components were scaled, while maintaining a consistent centre of rotation. Simulations encompassing the full range of abduction and adduction were conducted for the planes of elevation between -15˚ and 135˚ at 15˚ intervals, with the motion of the humerus being constrained in neutral internal-external rotation throughout all planes. Angles of elevation were obtained utilizing the humeral long axis and the RTSA centre of rotation. Statistical analysis was performed using repeated measures ANOVA.

**Results:** Glenosphere diameter was found to significantly affect the adduction range of motion (p=0.043), in which the largest size provided approximately 17˚ more adduction range of motion than the smallest. However, abduction range of motion was not found to be significantly affected through the alteration of glenosphere size (p=0.449). The plane of elevation was not found to significantly affect abduction or abduction (p=0.585 & p=0.225, respectively).

**Conclusion:** Increasing glenosphere diameter resulted in an increased adduction range of motion when averaged across the tested planes of elevation; however the observed influence on abduction was not significant. These are similar to the trends observed in the previous single plane of elevation studies. These findings illustrate the importance of implant sizing related to range of motion. Further studies are required to determine the influence of glenosphere size on internal and external range of motion.
9 - Total Shoulder Arthroplasty Restores Shoulder Motion Levels Similar to the Contralateral Side
G Daniel G Langohr, ON; John P Haverstock, ON; James A Johnson, ON; George S Athwal, ON

Purpose: Shoulder arthroplasty, both primary (TSA) and reverse (RTSA), are common interventions for arthritis and cuff tear arthropathy. The effect of shoulder arthroplasty on shoulder motion is of particular interest in assessing the effectiveness of the procedure and the development and biomechanical testing of implants. A comparison of the arthroplasty shoulder to that of the non-operated contralateral shoulder provides insight into how well the reconstruction has restored natural shoulder motion. The purpose of this study was to ascertain the shoulder motion of patients who have undergone shoulder arthroplasty and to compare the motion of the reconstructed and contralateral natural sides.

Method: Eleven human subjects (70±9yrs) who had undergone total shoulder arthroplasty wore a custom instrumented shirt for the waking hours of one day. 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 discretized, and the operative and contralateral normal (control) shoulders were then compared.

Results: The majority of both the arthroplasty and control shoulder elevation motions took place below 80° of elevation, totaling on average 1910±373 and 1887±312 motions per hour, respectively. Conversely, elevations greater than 80° were significantly less with occurrences totaling only 55±31 and 78±41 motions per hour for the arthroplasty and control shoulders, respectively (p<0.01). Both the arthroplasty and control shoulder were at elevations below 80° for 88±7% and 87±7% of the day, respectively. When the total motion of the arthroplasty and non-operative control shoulders were compared, no statistically significant difference was detected (p=0.8), although the non-operated side exhibited marginally more motion than the operated side, an effect which was larger at higher elevation angles (p=0.3).

Conclusion: This study provides insight into the effects of shoulder arthroplasty on thoraco-humeral motion and compares it to the non-operative side. Interestingly, there were no significant differences measured between the arthroplasty and the control side, which may demonstrate the effectiveness of reconstruction on restoring natural shoulder motion. It is interesting to note that on average, each shoulder arthroplasty elevated above 80° approximately 55 times per hour, corresponding to just under 330,000 motions per year. Similarly, when elevations greater than 60° are extrapolated, the resulting yearly motions total approximately 1.5 million cycles (Mc), which suggests that the ‘duty cycle’ of the shoulder is similar to the hip, approximated to be between 1-2 Mc per year. Arthroplasty wear simulators should be calibrated to simulate these patterns of motion, and component design may be improved by understanding the kinematics of actual shoulder motion.
10 - PHOSPHO 1 is Essential for Normal Bone Fracture Healing
Mina W Morcos, QC; Hadil Al-Jallad, QC; Jose Luis Millan, CA; Reggie C. Hamdy, QC; Monzur Murshed, QC

Purpose: Bone fracture healing is regulated by a series of complex physicochemical and biochemical processes. One of these processes is bone mineralization, which is vital for normal bone development, its biomechanical competence and fracture healing. Phosphatase, orphan 1 (PHOSPHO1), a bone-specific phosphatase, has been shown to be involved in the mineralization of the extracellular matrix in bone. It can hydrolyze phosphoethanolamine and phosphocholine to generate inorganic phosphate, which is crucial for bone mineralization. Phospho1-/− mice show hypomineralized bone and spontaneous fractures. All these data led to the hypothesis that PHOSPHO1 is essential for bone mineralization and its structural integrity. However, no study to our knowledge has shown the effects of PHOSPHO1 on bone fracture healing. In this study, we examined how PHOSPHO1-deficiency might affect the healing and quality of the fractured bones in Phospho1-/− mice.

Method: We performed rodted immobilised fracture surgery on the right tibia of control wild type (WT) and Phospho1-/− mice (n=16 for each group) at eight weeks of age. Bone was left to heal for four weeks and then the mice were euthanized and their tibias were analysed using Faxitron X-ray analyses, microCT, histology and histomorphometry and three-point bending test.

Results: Our microCT and X-ray analyses revealed that the appearance of the callus and several static parameters of bone remodeling at the fracture sites were markedly different in WT and Phospho1-/− mice. We observed a significant increase of BS/BV, BS/TV and trabecular number and decrease in trabecular thickness and separation in Phospho1-/− callus in comparison to the WT callus. These observations were further confirmed by histomorphometry. The increased bone mass at the fracture sites of Phospho1-/− mice appears to be caused by increased bone formation as there is a significant increase of osteoblast number, while osteoclast numbers remained unchanged. There was a marked increase of osteoid volume over bone volume (OV/BV) in the Phospho-/− callus. Interestingly, the amount of osteoid was markedly higher at the fracture sites than that of normal trabecular bones. The three-point bending test showed that Phospho 1-/- fractured bone had more of an elastic characteristics than the WT bone as they underwent more of a plastic deformity before the breakage point compare to the WT.

Conclusion: Our work suggests that PHOSPHO1 plays an integral role during bone fracture repair. PHOSPHO1 can be an interesting target to improve the fracture healing process.

11 - Lithium Enhances Fracture Healing in Osteoporotic Bone
Kathak Vachhani, ON; Yufa Wang, ON; Diane Nam, ON; Cari Whyne, ON

Purpose: Predictable fracture healing fails to occur in 5-10% of cases. This is particularly concerning among individuals with osteoporosis. With an increasing aging population, one in three women and one in five men above the age of 50 experience fragility fractures. As such, there is a critical need for an
effective treatment option that could enhance fracture healing in osteoporotic bone. Lithium, the standard treatment for bipolar disorder, has been previously shown to improve fracture healing through modulation of the Wnt/beta-catenin pathway. We optimized the precise oral lithium administration parameters to improve mechanical strength and enhance healing of femoral fractures in healthy rats. A low dose of Lithium (20 mg/kg) administered seven days post fracture for a two week duration improved torsional strength by 46% at four weeks post fracture compared to non-treated animals. Application of lithium to enhance fracture healing in osteoporotic bone would have a significant healthcare impact and requires further study. Aim: To evaluate the efficacy of optimal lithium administration post fracture on quality of fracture healing in a rat osteoporotic model. Hypothesis: Lithium treatment in osteoporotic rats will improve the structural and mechanical properties of the healing bone despite the impaired nature of bone tissue.

**Method:** Sprague Dawley female rats (~350 g, age ~3 months) were bilaterally ovariectomized and maintained for 3 months to establish the osteoporotic phenotype. A unilateral, closed mid-shaft femoral fracture was created using a weight-drop apparatus. At seven days post fracture, the treatment group received 20 mg/kg-wt lithium chloride via oral gavage daily for 14 days. The control group received an equivalent dose of saline. All animals were sacrificed at day 28 and the femurs harvested bilaterally. Treatment efficacy was evaluated based on torsional loading and stereologic analysis.

**Results:** Lithium treatment positively impacted the healing femurs, with an average yield torque ~1.25-fold higher than in the saline group (200±36 vs. 163±31 N-mm, p=0.15). Radiographically, the lithium-treated rats had a high level of restored periosteal continuity, larger bridging and intercortical callus at the fracture site. These hallmarks of healing were generally absent in the saline group. The Lithium group had significantly higher total volume (624±32 vs. 568±95 mm³), lower bone volume fraction (41±4 vs. 50±5 %) and higher theoretical torsional rigidity (477±50 vs. 357±93 kN-mm²) compared to the saline group. Torsional strength and stereology values were similar for the contralateral femurs of the two groups.

**Conclusion:** Lithium was found to enhance fracture healing in osteoporotic bone under the dosing regimen optimized in healthy femora. This is promising data as treatment represents an easily translatable pharmacological intervention for fracture healing that may ultimately reduce the healthcare burden of osteoporotic fractures.

12 - Biocompatibility of Bone Allograft Toughened with a Novel Irradiation-driven Sterilization Method for Large Segmental Defects: An in vivo Rabbit Study

Sam Si-Hyeong Park, ON; Peter Salat, ON; Kate Banks, ON; Thomas Willett, ON; Marc Grynpas, ON

**Purpose:** Structural bone allografts are a viable option in reconstructing massive bone defects in patients following musculoskeletal (MSK) tumour resection and revision hip/knee replacements. To decrease infection risk, bone allografts are often sterilized with gamma-irradiation, which consequently degrades the bone collagen connectivity and makes the bone brittle. Clinically, irradiated bone allografts fracture at rates twice that of fresh non-irradiated allografts. Our lab has developed a method that protects the bone collagen connectivity through ribose pre-treatment while still undergoing gamma-irradiation. Biomechanical testing of bone pretreated with our method provided 60-70% protection of
toughness and 100% protection of strength otherwise lost with conventional irradiation. This study aimed to determine if the ribose-treated bone allografts are biocompatible with host bone.

**Method:** The New Zealand White rabbit (NZWr) radius segmental defect model was used, in which 15-mm critically-sized defects were created. Bone allografts were first harvested from the radial diaphysis of donor female NZWr, and treated to create 3 graft types: C=untreated controls, I=conventionally-irradiated (33 kGy), R=our ribose pretreated + irradiation method. Recipient female NZWr (n=24) were then evenly randomized into the 3 graft groups. Allografts were surgically fixed with a 0.8-mm Kirschner wire. Post-operative X-rays were taken at 2, 6, and 12 weeks, with bony healing assessed by a blinded MSK radiologist using an established radiographic scoring system. The reconstructed radii were retrieved at 12 weeks and analyzed using bone histomorphometry and microCT. Kruskal-Wallis and Mann-Whitney tests were utilized to compare groups, with statistical significance when p<0.05.

**Results:** Radiographic analysis revealed no differences in periosteal reaction and degree of osteotomy site union between the groups at any time point. Less cortical remodeling was observed in R and I grafts compared to untreated controls at 6 weeks (p=0.004), but was no longer evident by 12 weeks. Radiographic union was achieved in all groups by 12 weeks. Histologic and microCT analysis further confirmed union at the graft-host bone interface, with the presence of mineralizing callus and osteoid. Histomorphometry also showed the bridging external callus originated from host bone periosteum and a distinct cement line between allograft and host bone was present at the union site.

**Conclusion:** Previous studies have shown that the presence of non-enzymatic glycation end products in bone can impair fracture healing. However, these studies investigated bony healing in the setting of diabetic states. Our findings showed that under normal conditions, ribose pretreated grafts healed at rates similar to controls via mechanisms also seen in retrieved human allografts clinically in use. These findings that grafts pretreated with our method are biocompatible with host bone in the rabbit help to further advance this technology for clinical trials.

13 - A Novel Signaling Pathway in Osteogenesis: IL-17F Activates Osteoblast Maturation via C/EBP-beta

Diane Nam, ON; Yufa Wang, ON; Heather Whetstone, ON; Benjamin Alman, US

**Purpose:** The T-lymphocyte secreted pro-inflammatory cytokine, interleukin-17F (IL-17F), was found to be a key mediator in the cellular response of the immune system in the early phase of fracture repair but its intracellular signaling processes are currently not known in osteoblasts. The objective of this study was to identify the signaling proteins and crucial gene targets involved in osteoblast activation via IL-17F. It was hypothesized that IL-17F stimulated osteoblast maturation through a novel GSK3beta / beta-catenin independent pathway.

**Method:** Mouse pre-osteoblast cell line (MC3T3-E1) was used for IL-17F or Wnt3a treatment. Desired proteins were detected using western blot analysis (antibodies: Phospho-GSK-3beta (Tyr 216), Phospho-GSK-3beta (Ser9), Runx2/cbfa1, TRAF6, Act1, p-ERK2, p-JNK and p-MAPK, C/EBP-beta and & delta). Gene-specific siRNAs of mouse IL-17Ra, IL-17Rc and a non-targeting siRNA (control) were utilized. MC3T3-E1 were transfected with IL-17Ra, IL-17Rc or Negative Control and treated with IL-17F.
Chromatin Immunoprecipitation (ChIP-qPCR) was used to evaluate the mouse Runx2 P1 promoter region.

**Results:** IL-17F increased expression of Col1, BSP, Runx2/cbfa1 and osteocalcin in MC3T3-E1 cells. Western blot analysis confirmed expression of known Wnt signaling proteins TRAF6, Act1, p-ERK2, p-JNK and p-MAPK in both IL-17F and Wnt3a treated cultures, including up-regulation of Runx2/cbfa1, a key transcription factor associated with osteoblast differentiation. IL-17F up-regulation of Runx2/cbfa1 appears independent of the Wnt/beta-catenin pathway as phosphorylated GSK-3beta at the Ser9 site was not detected with IL-17F treatment. Despite this, IL-17F treatment still increased expression of Runx2/cbfa1 downstream, lending evidence for a GSK3beta/beta-catenin independent manner of IL-17F stimulated osteogenesis. While IL-17F and Wnt3a both induced expression of C/EBP-delta, only IL-17F treatment induced expression of C/EBP-beta, an upstream transcription factor of Runx2/cbfa1. Further, siRNA knock down of the IL-17 receptors directly decreased Act1, C/EBP-beta and Runx2/cbfa1 expression. By ChIP analysis, IL-17F was shown to upregulate C/EBP-beta expression and stimulated its binding to the P1 Promoter of the Runx2/cbfa1 gene.

**Conclusion:** The C/EBP-beta transcription factor was shown to be a key regulator of early osteogenesis. C/EBP-beta up-regulates Runx2/cbfa1 expression by directly binding to the Runx2/cbfa1 P1 promoter in osteoblasts. C/EBP-beta was activated in the osteoblast by IL-17F but not by Wnt3a adding further support to a novel GSK3beta/beta-catenin independent pathway. Our data shows that IL-17F, a cytokine secreted by T-lymphocytes, stimulates osteoblast maturation through a novel GSK3beta/beta-catenin independent pathway and reveals a crucial interaction between C/EBP-beta and the Runx2/cbfa1 P1 promoter not previously been shown in osteogenesis signaling further.

**14 - Osteocytes’ Response to Mechanical Loading Supports Cancer Cell Growth and Migration, but Reduces Osteoclasts’ Support of Cancer Cells**

**Yu-Heng Ma, ON; Shreyash Dalmia, ON; Peter Gao, ON; Jacob Young, ON; Chao Liu, ON; Lidan You, ON**

**Purpose:** Bone metastases are common and severe complications of cancers. It is estimated to occur in 65-75% of breast and prostate cancer patients and cause 80% of breast cancer-related deaths. Metastasized cancer cells have devastating impacts on bone due to their ability to alter bone remodeling by interacting with osteoblasts and osteoclasts. Exercise, often used as an intervention for cancer patients, regulates bone remodeling via osteocytes. Therefore, we hypothesize that bone mechanical loading may regulate bone metastases via osteocytes. This provides novel insights into the impact of exercises on bone metastases. It will assist in designing cancer intervention programs that lowers the risk for bone metastases. Investigating the mechanisms for the observed effects may also identify potential drug targets.

**Method:** MLO-Y4 osteocyte-like cells (gift of Dr. Bonewald, University of Missouri-Kansas City) on glass slides were placed in flow chambers and subjected to oscillatory fluid flow (1Pa; 1Hz; 2 hours). Media were extracted (conditioned media; CM) post-flow. RAW264.7 osteoclast precursors were conditioned in MLO-Y4 CM for 7 days. Migration of MDA-MB-231 breast cancer cells and PC3 prostate cancer cells towards CM was assayed using Transwell. Viability, apoptosis, and proliferation of the cancer cells in the
CM were measured with Fixable Viability Dye eFluor 450, APOPercentage, and BrDu, respectively. P-values were calculated using Student’s t-test.

**Results:** Significantly more MDA-MB-231 and PC3 cells migrated towards the CM from MLO-Y4 cells with exposure to flow in comparison to CM from MLO-Y4 cells not exposed to flow. The preferential migration is abolished with anti-VEGF antibodies. MDA-MB-231 cells apoptosis rate was slightly lower in CM from MLO-Y4 cells exposed to flow, while proliferation rate was slightly higher. The current data showed no difference in cancer cells viability and adhesion to collagen between any two groups. On the other hand, it was observed that less MDA-MB-231 cells migrated towards CM from RAW264.7 cells conditioned in CM from MLO-Y4 cells stimulated with flow in comparison to those conditioned in CM from MLO-Y4 cells not stimulated with flow. TRAP staining results confirmed that there were less differentiated osteoclasts when RAW264.7 cells were cultured in CM from MLO-Y4 cells exposed to flow.

**Conclusion:** Overall, this study suggests that when only osteocytes and cancer cells are involved, osteocytes subjected to mechanical loading can promote metastases due to the increased secretion of VEGF. However, with the incorporation of osteoclasts, mechanical loading on osteocytes seems to reduce MDA-MB-231 cell migration. This is likely because osteocytes reduce osteoclastogenesis in response to mechanical stimulation, and osteoclasts have been shown to support cancer cells. Animal studies will also be conducted to verify the pro- or anti-metastatic effect of mechanical loading that is observed in the in vitro part of this study.

15 - Aging and Surgically-induced Menopause Affect Lubricin mRNA Levels in Rabbit Knee Ligaments
Gail Thornton, AB; Devin Lemmex, AB; Yohei Ono, AB; David A Hart, AB; Ian KY Lo, AB

**Purpose:** Lubricin is a proteoglycan that is a boundary lubricant in synovial joints and both a surface and collagen inter-fascicular lubricant in ligaments. The purpose of this study was to characterize the mRNA levels for lubricin in the anterior cruciate ligament (ACL), posterior cruciate ligament (PCL), medial collateral ligament (MCL), and lateral collateral ligament (LCL) in aging and surgically-induced menopausal rabbits. We hypothesized that lubricin mRNA levels would be increased in ligaments from aging and menopausal rabbits compared with ligaments from normal rabbits.

**Method:** All four knee ligaments (ACL, PCL, MCL, LCL) were isolated from normal (1-year-old rabbits, n=8), aging (3-year-old rabbits, n=6), and menopausal (1-year-old rabbits fourteen weeks after surgical ovariectomy, n=8) female New Zealand White rabbits. RT-qPCR was used to evaluate the mRNA levels for lubricin normalized to the housekeeping gene 18S. After removing outliers, data for normal, aging, and menopausal rabbits for each knee ligament (ACL, PCL, MCL, LCL) were compared using ANOVA with linear contrasts or Kruskal-Wallis test with Conover post-hoc analysis.

**Results:** For ACLs, the mRNA levels for lubricin were increased in menopausal and aging rabbits compared with normal rabbits (p<0.056). For PCLs, trends for increased lubricin mRNA levels were found when comparing menopausal and aging rabbits with normal rabbits (p<0.092). For MCLs, the mRNA levels for lubricin were increased in menopausal and aging rabbits compared with normal rabbits (p<0.050). For LCLs, no differences in lubricin mRNA levels were detected comparing the three groups.
For all four knee ligaments (ACL, PCL, MCL, LCL), no differences in lubricin mRNA levels were detected comparing the ligaments from menopausal rabbits with those from aging rabbits.

**Conclusion:** Lubricin plays a role in collagen fascicle lubrication in ligaments (1,2). Increased lubricin gene expression was associated with mechanical changes (including decreased modulus and increased failure strain) in the aging rabbit MCL (3). Detection of similar molecular changes in the ACL, and possibly the PCL, may indicate that their mechanical properties may also change as a result of increased lubricin gene expression, thereby potentially pre-disposing these ligaments to damage accumulation. Compared to aging ligaments, aging tendons exhibited decreased lubricin gene and protein expression, and increased stiffness (4). Although opposite changes than aging ligaments, these findings support the relationship between lubricin and modulus/stiffness. The similarities between ligaments in the aging and menopausal groups may suggest that surgically-induced menopause results in a form of accelerated aging in the rabbit ACL, MCL and possibly PCL.


16 - The Effect of Purified Multi-potent Bone-marrow Derived Human Mesenchymal Stem Cells on Rotator Cuff Tendon Healing in an Athymic Rat: Is Regenerative Healing Possible?


**Purpose:** Bone marrow concentrates are being used to augment soft tissue healing. However, only 0.01% of these cells meet the criteria of a mesenchymal stem cell (MSC), which likely accounts for the variability in reported results. Previous studies using an established rat rotator cuff repair model have demonstrated that bone marrow-derived MSCs had no effect on healing. In this study we evaluated the effect of purified human MSCs on rotator cuff healing in an athymic rat model. Hypothesis: Purified human MSCs added to the repair site will improve biomechanical strength and fibrocartilage formation of the healing tendon.

**Method:** Fifty-two athymic rats underwent unilateral detachment and repair of the supraspinatus tendon with either fibrin glue (control) or fibrin glue with 106 hMSCs (experimental) applied at the repair site. Flow cytometry verified the stem cell phenotype of the cells as CD73+, CD90+, CD105+, CD14-, CD34- and CD45-. Rats were sacrificed at 2 and 4 weeks, with 10 used for biomechanical testing and 3 for histologic analysis from each group.

**Results:** Biomechanical testing revealed a significant increase in failure load (11.5±2.4N vs. 8.5±2.4N, p=0.002) and stiffness (7.1±1.2 N/mm vs. 5.7±2.1 N/mm, p=0.17).

**Conclusion:** These data demonstrate the potential for stem cells to augment tendon healing. This is the first study to use purified stem cells, rather than simple bone marrow concentrate. In the future, cell sorting techniques and culture expansion could be used to select and expand the small population of
true stem cells in bone marrow. Furthermore, healing could potentially be improved with repeat cell injection at an additional post-operative time point.

17 - A Comparison of Double Screw vs. Quadruple Button Fixation for the Latarjet Procedure
Jacob M Reeves, ON; George S Athwal, ON; James A Johnson, ON

Purpose: To evaluate the efficacy of using a novel button-suture construct in place of traditional screws to provide bone block fixation for the Latarjet procedure.

Method: Four paired cadaveric shoulders (n=8) were denuded, with the exception of the conjoint tendon on the coracoid, and were potted. A 15% anterior glenoid bone defect was simulated. Right and left specimens were randomized into two groups: double-screw versus quadruple-button Latarjet reconstruction techniques. A uniaxial mechanical actuator loaded the Latarjet reconstructed glenoid articular surface via a 47mm diameter metallic hemisphere. Cyclic loading between 50-200N was applied to the glenoid at a rate of 1Hz for 1000 cycles. Testing was repeated three times for conjoint tendon loads of 0N, 10N and 20N. The relative positions of three points on the inferior, central and superior edges of the coracoid bone fragment were optically tracked with respect to a glenoid coordinate system throughout testing. Screw and button constructs were compared on the basis of maximum relative displacement at these points (RINF, RCENT, RSUP). Statistical significance was assessed using a paired-samples t-test in SPSS.

Results: When conjoint tendon loading was not present the double screw and quadruple button constructs were not significantly (P>0.779) different (0N: RINF: 0.11 (0.05)mm vs. 0.12 (0.03)mm, RCENT: 0.12 (0.04)mm vs. 0.12 (0.03)mm, RSUP: 0.13 (0.04)mm vs. 0.12 (0.03)mm). Additionally, the double screw construct was not found to differ (P>0.062) from the quadruple button in terms of resultant coracoid displacement for all central and superior points, regardless of conjoint loading (10N: RCENT: 0.11 (0.03)mm vs. 0.19 (0.05)mm, RSUP: 0.11 (0.01)mm vs. 0.18 (0.04)mm; 20N: RCENT: 0.13 (0.01)mm vs. 0.30 (0.13)mm, RSUP: 0.13 (0.03)mm vs. 0.26 (0.14)mm). It was only for the inferior point with conjoint loading of 10N and 20N that the double screw construct began to produce significantly lower displacements than the quadruple button (10N: RINF: 0.11 (0.03)mm vs. 0.23 (0.05)mm, P=0.047; 20N: RINF: 0.12 (0.02)mm vs. 0.39 (0.15)mm, P=0.026).

Conclusion: The results of the screw and button constructs when conjoint tendon loading was absent suggest that the button may be a suitable substitute to the screw when the coracoid is used as a bone block. Due to the small resultant displacements (max: screw = 0.19mm, button = 0.52mm), it is suggested that buttons may also act as a substitute to screws for Latarjet procedures, provided conjoint tendon overloading is minimized during the post-operative graft healing period. These in-vitro results support the in-vivo results of Boileau et al (2015) that demonstrated the suture-button technique to be an excellent alternative to screw fixation Latarjet, with graft healing in 91% of their subjects.
18 - Preoperative Predictors of Catastrophizing, Anxiety and Depression in Patients Undergoing Total Joint Replacement

Thomas J Wood, ON; Patrick Thornley, ON; Danielle Petruccelli, ON; Conrad Kabali, ON; Mitch Winemaker, ON; Justin de Beer, ON

Purpose: The relationship between pain catastrophizing and emotional disorders including anxiety and depression in patients with osteoarthritis (OA) undergoing total joint replacement (TJR) is an emerging area of study. The purpose of this study was to examine the association between pain catastrophizing, anxiety, depression and preoperative patient characteristics.

Method: A prospective cohort study of preoperative TJR patients at one centre over 12-months was conducted. We examined association between catastrophizing, anxiety, depression and preoperative patient characteristics including demographics, pain and function. Pain catastrophizing was assessed using the Pain Catastrophizing Scale (PCS), and anxiety/depression using the Hospital Anxiety and Depression Scale (HADS-A, HADS-D). Patient perceived level of hip/knee pain was measured using a visual analogue (VAS) pain scale. Patient perception of function was measured using the Oxford Score. Preoperative radiographic grading of OA was determined using the Kellgren and Lawrence (K-L) scale. Logistic regression was used to assess pattern of relationship between preoperative characteristics and PCS or HADS. Adjusted odds ratio (OR) and 95% confidence interval (CI) were reported. A secondary quantile regression analysis examined whether a model not restricted to pre-defined PCS and HADS categories would yield comparable results to the logistic regression model described in the primary analysis. P-values less than 0.05 were considered statistically significant.

Results: The sample included 463 TJR patients (178 hips, 285 knees). VAS pain (OR 1.23, 95%CI 1.04-1.45) and Oxford score (OR 1.13, 95%CI 1.07-1.20) were identified as significant predictors for PCS. The same two variables were the strong predictors for all sub-domains of PCS excluding rumination. Oxford Score was the only significant predictor for abnormal HADS-A (OR 1.10, 95%CI 1.04-1.17) while VAS pain (OR 1.27, 95%CI 1.02-1.52) and Oxford (OR 1.09, 95%CI 1.01-1.17) were significant predictors for abnormal HADS-D. Similar pattern of association for PCS and HADS was observed in the quantile regression model, where larger VAS pain and Oxford scores significantly increased median PCS across all domains. Female gender, younger age or having a higher ASA grade were associated with higher median HADS-A, but unlike in the logistic regression, this association was statistically significant.

Conclusion: Pain catastrophizing and emotional disorders generally result in poor functional outcomes in TJR patients. The most important predictor of catastrophizing, anxiety/depression is pain and subjective function. At risk patients include those with high preoperative pain with generally good preoperative function, as well as younger females with significant comorbidities. Such patients should be identified, and targeted psychological therapy implemented preoperatively to optimize coping strategies and adaptive behaviour to mitigate inferior TJR outcomes including pain and patient dissatisfaction.

19 - Simulation of Arthroscopic Rotator Cuff Repair and Labral Repair in a Dry Model
Rachel Ann Schachar, AB; Tim Dwyer, ON; Tim Leroux, ON; Rachel Greben, ON; Mahan Kulasegaram, ON; Patrick Henry, ON; Darrell Ogilvie-Harris, ON; John Theodoropoulos, ON; Jas Chahal, ON

Purpose: The purpose of this study was to validate a dry model for the assessment of performance of arthroscopic rotator cuff repair (RCR) and labral repair (LR). We hypothesized that the combination of a checklist and a previously validated global rating scale (GRS) would be a valid and reliable means of assessing RCR and LR when performed by residents in a dry model.

Method: An arthroscopic RCR and LR was performed on a dry model by residents, fellows, and sports medicine staff. Any prior RCR and LR exposure was noted. Participants were given a detailed surgical manuscript and technique video before the study began. Evaluation of residents was performed by staff surgeons with task-specific checklists created using a modified Delphi procedure, and the Arthroscopic Surgical Skill Evaluation Tool (ASSET). The hand movements and arthroscopic view of the procedures were recorded. Both videos were scored by a fellow blinded to the year of training of each participant.

Results: A total of 35 residents, six fellows and five staff surgeons performed both arthroscopic RCR and LR on a dry model model (48 total). The internal reliability (Cronbach’s Alpha) of the test using the total ASSET score was high (>0.8)). One-way analysis of variance for the total ASSET score and the total checklist score demonstrated a difference between participants based upon year of training (p <0.05). Post hoc analysis also demonstrated a significant difference in global ratings and checklist scores between junior residents (PGY1-3) and senior residents (PGY4&5), senior residents and fellows, and fellows and staff. A good correlation was seen between the total ASSET score and prior exposure to RCR and LR . The inter-rater reliability (ICC) between the examiner ratings and the blinded assessor ratings for the total ASSET score was good (0.8).

Conclusion: The results of this study provide evidence that the performance of a RCR and LR in a dry model is a valid and reliable method of assessing a resident’s ability to perform these procedures, prior to performance in the operating room.

20 - Trends, Deficiencies and Levels of Evidence of Orthopaedic Research in Low-income Countries: A Systematic Review
Malik Mohamed Elharram, QC; Thierry Pauyo, QC; Ryan Coughlin, QC; Stephane Bergeron, QC

Purpose: The World Health Organization (WHO) has recently identified musculoskeletal care as a major global health issue in the developing world. However, little is known about the quality and trends of orthopaedic research in resource-poor settings. The purpose of this study was to perform a systematic review of orthopaedic research in low-income countries (LIC). The primary objective was to determine the quality and publication parameters of studies performed in LIC. Secondary objectives sought to provide recommendations for successful strategies to implement research endeavors in LIC.

Method: A systematic review of the literature was performed by searching MEDLINE (1966-November 2014), EMBASE and the Cochrane Library to identify peer-reviewed orthopaedic research conducted in LICs. The PRISMA guidelines for performing a systematic review were followed. LIC were defined by the WHO and by the World Bank as countries with gross national income per capita equal or less than
Inclusion criteria were (1) studies performed in a LIC, (2) conducted on patients afflicted by an orthopaedic condition, and (3) evaluated either an orthopaedic intervention or outcome. The Oxford Centre for Evidence-Based Medicine Levels of Evidence, and Grading of Recommendations Assessment, Development and Evaluation (GRADE) were used to objectively rate the overall methodological quality of each study. Additional data collected from these studies included the publication year, journal demographics, orthopaedic subspecialty and authors’ country of origin.

Results: A total of 1,809 articles were screened and 277 studies met our inclusion criteria. Eighty-eight percent of studies conducted in LIC were of lower quality evidence according to the GRADE score and consisted mostly of small case series or case reports. Bangladesh and Nepal were the only two LIC with national journals and produced the highest level of research evidence. Foreign researchers produced over 70% of the studies with no collaboration with local LIC researchers. The most common subspecialties were trauma (42%) and paediatrics (14%). The 3 most frequent countries where the research originated were the United States (42%), United Kingdom (11%), and Canada (8%). The 3 most common locations where research was conducted were Haiti (18%), Afghanistan (14%), and Malawi (7%).

Conclusion: The majority of orthopaedic studies conducted in LIC were of lower quality and performed by foreign researchers with little local collaboration. In order to promote the development of global orthopaedic surgery and research in LIC, we recommend (1) improving the collaboration between researchers in developed and LIC, (2) promoting the teaching of higher-quality and more rigorous research methodology through shared partnerships, (3) improving the capacity of orthopaedic research in developing nations through national peer-reviewed journals, and (4) dedicated subsections in international orthopaedic journals to global healthcare research.

21 - A Pilot Study of the Usability and Viability of Adverse Event Recording Tools in Elective Spine and Orthopaedic Surgery Patients

Brian P Chen, ON; Katie PY Garland, ON; Darren M Roffey, ON; Stephane Poitras, ON; Peter Lapner, ON; Geoffrey Dervin, ON; Philippe Phan, ON; Eugene K Wai, ON; Stephen P Kingwell, ON; Paul E Beaulé, ON

Purpose: The Spine Adverse Events Severity System (SAVES) and Orthopaedic Surgical Adverse Events Severity System (OrthoSAVES) are standardized assessment tools designed to record adverse events (AEs) in orthopaedic patients. The primary objective was to compare AEs recorded prospectively by orthopaedic surgeons compared to trained independent clinical reviewers. The secondary objective was to compare AEs following spine, hip, knee, and shoulder orthopaedic procedures.

Method: Over a 10-week period, three orthopaedic spine surgeons recorded AEs following all elective procedures to the point of patient discharge. Three orthopaedic surgeons (hip, knee, and shoulder) also recorded AEs for their elective procedures. Two independent reviewers used SAVES and OrthoSAVES to record AEs after reviewing clinical notes by surgeons and other healthcare professionals (e.g. nurses, physiotherapists). At discharge, AEs recorded by the surgeons and independent reviewers were recorded in a database.
Results: AE data for 164 patients were collected (48 spine, 52 hip, 33 knee, and 31 shoulder). Overall, 98 AEs were captured by the independent reviewers, compared to 14 captured by the surgeons. Independent reviewers recorded significantly more AEs than surgeons overall, as well as for each individual group (i.e. spine, hip, knee, shoulder) (p<0.05). AEs were reported in 21 (43.8%), 19 (36.5%), 12 (36.4%), and five (16.1%) spine, hip, knee, and shoulder patients, respectively. Nearly all reported AEs required only simple or minor treatment (e.g. antibiotic, foley catheter) and had no effect on outcome. Two patients experienced AEs that required invasive or complex treatment (e.g. surgery, monitored bed) that had a temporary effect on outcome.

Conclusion: Similar complication rates were reported in spine, hip, knee, and shoulder patients. Independent reviewers reported more AEs compared to surgeons. These findings suggest that independent reviewers are more effective at capturing AEs following orthopaedic surgery, and thus, could be recruited in order to capture more AEs, enhance patient safety and care, and maximize different complication diagnoses in alignment with proposed diagnosis-based funding models.

22 - A Qualitative Assessment of the Role of 'Boot Camps' in Surgical Residency
Brandon Girardi, ON; Lisa Satterthwaite, ON; Maria Mylopoulos, ON; Carol-Anne Moulton, ON; Lucas Murnaghan, ON

Purpose: There has been a widespread adoption of training programs or “boot-camps” targeting new surgical residents prior to entrance to the hospital environment. A plethora of studies have shown positive reactions to implementations of “boot camps”. Reaction surveys, however, lack the ability to provide a deeper level of understanding into how and why “boot camps” are seen as effective. The purpose of this study was to develop a rich perspective on the role “boot camps” are perceived to play in resident education.

Method: A constructivist approach to qualitative grounded theory methodology, employing iterative semi-structured, in-person, interviews was used to explore the construct of a “boot camp” through the eyes of key stakeholders, including junior surgical residents (n=10), senior surgical residents (n=5), and faculty members (n=5) at a major academic centre. Interviews were coded and analyzed thematically using NVIVO software. Three members of the research team coded data independently and compared themes until consensus was reached. A method of constant comparative analysis was utilized throughout the iterative process. Emerging themes were revisited with stakeholders as a measure of rigor. Axial coding of themes was used to discover the overlying purposes embedded in the “boot camp” construct.

Results: The overarching themes resonating from participants were ‘anxiety reduction’, ‘cognitive unloading’ and ‘practical logistics’. Resident anxiety was ameliorated through subthemes of ‘social inclusion’, ‘group formation’, ‘confidence building’ and ‘formalization of expectations’. A resident commented “the nuances of how things work is more stressful than the actual job.” Residents bonded together to create personal and group identities, “forming the identity of who we are as a group”, that shaped ongoing learning throughout training, “right from the beginning we would be able to call on each other.” Junior residents found themselves cognitively unloaded for higher level learning through
‘expectation setting’ and ‘formalized basic skills’; “I knew how the equipment was going to fit together, it allowed me to focus more on what was happening from the operative perspective.” Stakeholders highlighted the importance of positioning “boot camp” at the beginning of residency training, as it directly influenced the point of transition. This highlights the strength of the “boot camp” construct at targeting the challenges associated with discrete moments of transition in the advancement in practice.

**Conclusion:** While surgical preparatory “boot camps” were initially born out of a competency-based framework focused on technical skill development, our findings demonstrate that the benefits outweigh simple improvement in technical ability. The formation of a learner group identity has downstream effects on resident perceptions of anxiety and confidence, while priming for higher-level learning. "Boot camp" then, is re-imagined as an experience of social professional enculturation.

### 23 - Outcomes of Hip and Knee Total Joint Arthroplasty in the Kingston Inmate Population Over a 10-year Period

**Sebastien Lalonde, ON; Rick Lau, ON; Gavin Wood, ON; Kelly Harper, ON**

**Purpose:** The inmate population is a unique cohort with several healthcare-related challenges. International studies have demonstrated higher rates of infectious diseases, chronic diseases and psychiatric disorders in inmates when compared to general population. However, little is known about the outcomes following total joint arthroplasty in this population. This retrospective chart review aims to outline the differences in clinical outcomes after hip and knee total joint arthroplasty in the Kingston inmate population compared to the national population standard.

**Method:** A list of all inmate inpatient hospital visits with diagnostic/procedure codes pertaining to total joint arthroplasty within the last ten years was obtained through a computer-based search of the Kingston General Hospital Discharge Abstract Database(DAD). The patient charts were reviewed and demographic and outcome data pertinent to our study was collected. Data was compiled using Excel and imported into IBM SPSS for descriptive analysis.

**Results:** Twenty male inmate patients underwent 24 primary Total Hip Arthroplasties(THA) or Total Knee Arthroplasties(TKA) and one medial unicompartmental knee arthroplasty from May 2003 to January 2013. The average age was 58 with mean Body Mass Index(BMI) of 34. Median American Society of Anesthesiologist(ASA) score was 3 and mean Charleston Comorbidity Index was 3.92. The rates of HCV and HIV were 35%(n=5) and 0%, respectively. Average length of stay from time of initial procedure was 4.2 days. The overall revision rate was 24% (n=6). Reasons for revision included deep prosthetic infection (50%, n=3), aseptic loosening (17%, n=1), arthrofibrosis (17%, n=1) and late periprosthetic fracture (17%, n=1). Infection rates were reported at 16% (n=4); 75% of which were deep prosthetic infections requiring revision surgery. Other complications included ST-elevation myocardial infarction(STEMI) (n=1), and postoperative knee stiffness requiring manipulation under anesthesia(MUA) (n=1).

**Conclusion:** Compared to Correctional Services Canada(CSC) data on male inmate health in 2012, our study population demonstrated a higher rate of HCV (35% vs. 9.4%), diabetes (30% vs. 4.2%) and overall cardiovascular and respiratory comorbidities. This may reflect the higher rate of comorbidities
associated with osteoarthritis, such as BMI>25, which was evident in 95% of our study population vs. 64.5% in Canadian inmates. Total joint revision rates in our inmate study population was 24%, which is higher than the 2014 Canadian Joint Replacement Registry’s yearly revision rate of 8.7% in THA and 5.2% in TKA. Our study population also demonstrated infection as the leading cause for revision at 50%, compared to 14.5% for THA and 19.6% for TKA in the general Canadian population. Further study of the complex biopsychosocial risk factors in the inmate population is warranted to better define pre-surgical risk assessment criteria.

24 - Independent Learning vs Mentorship with the Introduction of New Surgical Skills: A Pilot Study
Emanuele Serra, ON; Paul Beaulé, ON; Wade Gofton, ON

Purpose: With the rapid evolution of surgical techniques every practicing surgeon will need to introduce new skills into their 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 procedure into established practice. The purpose of this pilot study was to compare the effects of a mentored approach to learning new technical skills in practice to an unmentored approach.

Method: A mentorship partnership and learning protocol was developed between a learning surgeon and an expert in the Direct Anterior Approach (DAA) total hip arthroplasty. After training in the technique the learning surgeon was directly supported in the first 3 cases and mentored for the first 15 cases.

Results: Outcomes (surgical times, estimated blood loss, canal fit and fill, acetabular inclination and version, and complications) for the learning surgeons first 30 cases were assessed and compared to another learned cohort (first 30 cases of a percutaneously assisted total hip arthroplasty) integrated into practice without the support of a mentor. This data allow for the comparison of learning curves between the 2 techniques.

Conclusion: Use of a mentored approach to the introduction of a new surgical skill was demonstrated to be a safe and more efficient than with an independent introduction of skills. The surgical times and learning curve were reduced and anecdotally the surgeons stress level was markedly reduced with a mentored approach. These findings support further work into surgical mentorship for the safe introduction of surgical skills in practice.

25 - Evaluating a Residency Program, and the Milestones Themselves, after 18 Months of using a Real-time Mobile Platform for Milestone-based Feedback
Kenneth R Gundle, ON; Dayne Mickelson, US; Arien Cherones, US; Doug Hanel, US

Comments: Milestone-based outcome oriented training is now an important framework for residency education and program accreditation. Analyzing 18 months of Orthopaedic Surgery Patient Care Milestone real-time evaluations via a web platform in a single residency program demonstrated significant variability in the rate of assessment and competency level among Milestones. In 614 evaluations, there was a strong, positive linear relationship between postgraduate year and competency
level. Chief residents achieved an average competency level of 4.0, the graduation target, as assessed by faculty in real-time. These data may inform ongoing discussions about potential revisions to the Orthopaedic Surgery Milestones, and highlight one potential model for improving resident feedback.

**Purpose:** The Accreditation Council for Graduate Medical Education (ACGME) now requires the biannual submission of a variety of Milestones by United States residency programs, as part of a move towards competency-based medical training. Our program developed a web-based platform to collect Milestone-based evaluations in real-time, in an effort to improve feedback and facilitate ACGME compliance. After 18 months of use, we assessed how frequently each Milestone is evaluated in real-time, as well as the distribution of competency levels by each Patient Care Milestone and postgraduate year (PGY). These results may inform on relative strengths and weaknesses of a program, or of particular Milestones.

**Method:** At a single academic orthopaedic residency program with 40 residents in total, the use of a web-based trainee-driven evaluation tool (eMTRCS – electronic Milestone Tracking and Competency System) was initiated in 2014. Residents initiate evaluation in real-time, triggering a digital Milestone-based evaluation by a particular faculty member. De-identified data from January 2014 to December 2015 was abstracted. Descriptive statistics on the distribution of evaluations submissions, type of Milestone, faculty evaluation levels, and resident PGY were calculated. As the data was ordinal with evidence of non-normality, nonparametric tests were utilized to analyze differences in the distribution, and assess correlation between planned outcome variables.

**Results:** A total of 614 evaluations were included in the analysis, for an average of 38.4 evaluations per Patient Care Milestone. There was a wide variability in the number of evaluations per Milestone, ranging from only four “Diabetic Foot” submissions to 75 submissions on “Hip and Knee Arthritis” (Figure 1). Faculty-scored competency also varied significantly among the Milestones (Figure 2, p = 0.009 by Kruskal-Wallis rank sum test). Higher levels of competency were seen as resident PGY progressed (mean = 2.1, 2.4, 3.1, 3.7, 4.0 for PGY1-5 respectively, p <0.001).

**Conclusion:** Through 18 months of use and 614 real-time evaluations, a web-based system for assessing Milestone levels showed significant variability in the number of assessments and competency level among the Orthopaedic Surgery Patient Care Milestones. There are multiple possible explanations, ranging from resident and faculty confusion about the Milestones to a lack of clinical volume in specific areas. In contrast to the inter-Milestone variability in assessments and competency levels, the strong stepwise relationship between advancing PGY and increasing levels of competency does provide evidence of validity for Milestone-based evaluations. Graduating residents in this program achieved, on average, the graduation target competency level as assessed by faculty in real-time.

26 - Misinterpretation of “Negative” Results of Superiority Trials in Orthopaedic Literature: The Need for Non-inferiority Trials
**Patricia Larouche, MB; Janice Andrade, BC; Christopher Reilly, BC; Kishore Mulpuri, BC**

**Purpose:** A commonly misunderstood principle in medical literature is statistical significance. Often, statistically non-significant or negative results are thought to be evidence for equivalence; mistakenly validating treatment modalities and putting patients at risk. This study examines the prevalence of
misinterpretation of negative results of superiority trials in orthopaedic literature and outlines the need for a non-inferiority or equivalence research design.

**Method:** Four orthopaedic journals - Journal of Paediatric Orthopaedics A, Journal of Bone and Joint Surgery American Volume, Journal of Arthroplasty and Journal of Shoulder and Elbow Surgery - were hand searched to identify all randomized control trials (RCTs) published within the time periods 2002-2003, 2007-2008 and 2012-2013. The identified RCTs were read and classified by study methodology, results obtained, and interpretation of results.

**Results:** A total of 237 RCTs were identified. When analyzing the primary outcomes, 117 (49.4%) studies yielded negative results and 120 (50.8%) yielded positive results. Out of the 237 articles, 231 (97.5%) used superiority methodology and 6 (2.5%) used non-inferiority or equivalence methodology. Of the 231 studies that used superiority methodology, 115 (49.8%) obtained negative results; and 45 (39.1%) of those misinterpreted the negative results for equivalence. While no statistical differences were seen, there was an upward trend in utilizing non-inferiority and equivalence methodologies over time.

**Conclusion:** Given the frequency of misinterpreted negative results, there is an evident need for a more appropriate research methodology that shows equivalence of treatment methods. A non-inferiority or equivalence study design can address orthopaedic clinical dilemmas more suitably when trying to show one treatment is no worse or is equal to another treatment. Regarding orthopaedic treatment modalities as equivalent when studies show negative statistical results can be detrimental to patients and their clinical outcomes. A non-inferiority methodology can be used to accurately depict no difference between treatment methods rather than attempting to show one treatment method as superior.

**27 - Skill Acquisition and Retention Following Simulated Pavlik Harness Learning**  
**Joel Moktar, ON;** Catharine S. Bradley, ON; Alexandra Maxwell, ON; John H. Wedge, ON; Simon P. Kelley, ON; M. Lucas Murnaghan, ON

**Purpose:** Simulated learning is increasingly prevalent in many surgical training programs as medical education moves towards competency based curricula. In orthopaedic surgery, developmental dysplasia of the hip is a commonly treated diagnosis where the standard of care in patients less than six months of age is an orthotic device such as the Pavlik Harness. However, despite widespread use of the Pavlik Harness and the potential complications that may arise from inappropriate application, no formal educational methods exist.

**Method:** A video and model based simulated learning module for Pavlik Harness application was developed. Two novice groups (residents and allied health professionals) were exposed to the module and at pre-intervention, post-intervention and retention testing were evaluated on their ability to apply a Pavlik Harness to the model. Evaluations were completed using a previously validated Objective Structured Assessment of Technical Skill (OSATS) and a Global Rating Scale (GRS) specific to Pavlik Harness application. A control group who did not undergo the module was also evaluated at two time points to determine if exposure to the Pavlik Harness alone would affect ability. All groups were
compared to a group of clinical experts who were used as a competency benchmark. Statistical analysis of skill acquisition and retention was conducted using t-tests and ANOVA.

**Results:** Exposure to the learning module improved resident and allied health professionals’ competency in applying a Pavlik Harness (p < 0.05) to the level of expert clinicians and this level of competency was retained one month after exposure to the module. Control subjects who were not exposed to the module did not improve nor did they achieve competency.

**Conclusion:** The simulated learning module has been shown to be an effective tool for teaching the application of a Pavlik Harness and learners demonstrated retainable skills post intervention. This learning module will form the cornerstone of formal teaching for Pavlik Harness application in developmental dysplasia of the hip.
Paper Session: COA Trauma 1: General

28 - Efficacy of Electrical Stimulators for Bone Healing: A Meta-analysis of Randomized Sham-controlled Trials
Mohit Bhandari, ON; Ilyas Aleem, ON; Idris Aleem, ON; Nathan Evaniew, ON; Jason Busse, ON; Michael Yaszemski, US; Arnav Agarwal, ON; Thomas Einhorn, US

Purpose: Electrical stimulators are commonly used to accelerate fracture healing, resolve nonunions or delayed unions, and to promote spinal fusion. The efficacy of electrical stimulator treatment, however, remains uncertain. We conducted a meta-analysis of randomized sham-controlled trials to establish the effectiveness of electrical stimulation for bone healing.

Method: We searched MEDLINE, EMBASE, CINAHL and Cochrane Central to identify all randomized sham-controlled trials evaluating electrical stimulators in patients with acute fractures, non-union, delayed union, osteotomy healing or spinal fusion, published up to February 2015. Our outcomes were radiographic nonunion, patient-reported pain and self-reported function. Two reviewers independently assessed eligibility and risk of bias, performed data extraction, and rated overall confidence in the effect estimates according to the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach.

Results: Fifteen randomized trials met our inclusion criteria. Electrical stimulation reduced the relative risk of radiographic nonunion or persistent nonunion by 35% (95% CI 19% to 47%; 15 trials; 1247 patients; number needed to treat = 7; p < 0.01; moderate certainty). Electrical stimulation also showed a significant reduction in patient-reported pain (Mean Difference (MD) on the 100-millimeter visual analogue scale = -7.67; 95% CI -13.92 to -1.43; 4 trials; 195 patients; p = 0.02; moderate certainty). Limited functional outcome data showed no difference with electrical stimulation (MD -0.88; 95% CI -6.63 to 4.87; 2 trials; 316 patients; p = 0.76; low certainty).

Conclusion: Patients treated with electrical stimulation as an adjunct for bone healing have a reduced risk of radiographic nonunion or persistent nonunion and less pain; functional outcome data are limited and requires increased focus in future trials.

29 - Clinical Impact of Shortening of the Clavicle After Conservative Treatment of Fractures in the Middle Third
Amerigo Balatri, QC; Simon Corriveau-Durand, QC; Mathieu Boulet, QC; Stéphane Pelet, QC

Purpose: There is no clear consensus regarding the indications for surgical treatment of middle third clavicle fractures. An initial shortening of 2 cm or more of the clavicle was associated with poor clinical outcomes and higher rate of non-union. The number needed to treat (NNT) clavicle fractures in order to prevent non-union ranges in the recent literature from 4.5 to 9.2. A direct relationship between shortening of the clavicle and a poor clinical outcome has not yet been demonstrated.

Method: Prospective cohort study performed in a Level one trauma center including 148 clavicle fractures treated conservatively. Eighty-five patients met the inclusion criteria (healed fracture in the middle third, no other upper limb lesions) and 63 were enrolled. A single assessment was realised at a
minimum one year follow-up by an independent examiner and consisted in Constant and DASH scores, range of motion, strength in abduction (Isobex) and a specific radiographic evaluation using a calibrated AP radiographs of both clavicles. Two groups were constituted and analysed according to a radiologic shortening > 2 cm (patients and assessor blinded). Sub-analyses were performed to find any relevant clinical threshold.

**Results:** The rate of shortening > 2cm in this cohort is 16.1% (10 patients). No clinical differences between the two groups for Constant scores (shortened > 2 cm = 96.0 ± 6.0 vs 95.2 ± 6.6, p=0.73) and DASH scores (8.4 ± 11.9 vs 5.4 ± 8.1, p=0.32). A slight loss in flexion was observed with a shortening > 2 cm (175 deg ± 8.5 vs 179.3 ± 3.4, p=0.007). No clinical threshold (in absolute or relative length) was associated with lower functional scores. No relationship between clinical results and patient characteristics. Interestingly, cosmesis was not an issue for patients.

**Conclusion:** This study could not demonstrate any clinical impact of the shortening of the clavicle in patients treated conservatively for a fracture in the middle third. Functional scores are excellent and the slight difference in flexion is not clinically significant. We were not able to found patients unsatisfied with their treatment. The poor functional outcomes described in previous studies are mainly related to non-unions. Just after the trauma, protraction of the scapula and single AP views centered on the clavicle can overestimate the real shortening. An initial shortening of the clavicle > 2 cm is not a surgical indication for fractures in the middle third; patient selection for surgery should focus on risk factors for non-unions.

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**30 - Incidence, Risk Factors and Location of Articular Malreductions of the Tibial Plateau**

**Ryan Martin, AB; Brad Meulenkamp, ON; Nicholas Desy, AB; Paul Duffy, AB; Rob Korley, AB; Shannon Puloski, AB; Richard Buckley, AB**

**Purpose:** Tibial plateau fractures are common injuries. Displaced fractures are treated with open reduction and internal fixation (ORIF). Goals of treatment include restoration of extremity axial alignment, joint stability and congruity, allowing for early motion and prevention of osteoarthritis. Short term results of surgical fixation of tibial plateau fractures are good, however, longer term outcomes have demonstrated a higher risk of end-stage arthritis and total knee arthroplasty. Despite the vast literature around tibial plateau fractures, to our knowledge there are no series examining post-operative reductions using axial imaging. It is our goal to define the incidence of articular malreductions following surgical fixation of tibial plateau fractures, to identify patient or surgeon factors associated with malreductions, and to define any regional patterns of malreduction location.

**Method:** De-identified post operative computed tomography (CT) scans were reviewed to identify tibial plateau malreductions with a step or gap greater than 2 mm, or condylar width greater than 5 mm. Three independent assessors reviewed the scans meeting criteria using Osirix DICOM software. Steps and gaps were mapped onto the axial sequence at the level of the joint line. Images were then matched to side and overlaid as best fit in Photoshop software to create a map of malreductions. A grid was created to divide the medial and lateral plateaus into quadrants to identify the density of malreductions by location. A multi-variate regression model was used to assess risk factors for malreduction.


**Results:** Sixty five post-operative CT scans were reviewed. Twenty one reductions had a step or gap more than 2 mm for a malreduction incidence of 32.3%. The incidence in patients undergoing submeniscal arthrotomy or fluoroscopic assisted reduction was 16.6% and 41.4%, respectively (p <0.001). Side of injury, age, BMI, AO fracture type, and use of locking plates were not predictive of malreduction. Malreductions were heavily weighted to the posterior lateral tibial plateau.

**Conclusion:** The incidence of articular malreductions was high at 32.3%. Fluoroscopic reduction alone was a predictor for articular malreduction with most malreductions located in the posterior lateral quadrants of the plateau.

31 - The Effect of Varying Tension of a Suture Button Construct in Fixation of the Tibiofibular Syndesmosis - Evaluation Using Stress Computed Tomography
John Morellato, ON; Hakim Louati, ON; Andrew Bodrogi, ON; Andrew Stewart, ON; Steve Papp, ON; Allan Liew, ON; Wade Gofton, ON

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

**Method:** Ten cadaveric lower limbs disarticulated at the knee were used. The limbs were placed in a modified external fixator frame that allows for the application of sustained torsional (5 Nm), axial (500 N) and combined torsional/axial (5Nm/500N) loads. Baseline CT scans of the intact ankle under unloaded and loaded conditions were obtaining. The syndesmosis and the deltoid ligament complex were then sectioned. The limbs were then randomized to receive a suture button construct tightened at 4 kg force (loose), 8 kg (standard), or 12 kg (maximal) of tension and CT scans under loaded and unloaded conditions were again obtained. Eight previously described measurements were taken from axial slices 10 mm above the tibiotalar joint to assess the joint morphology under the intact and repair states, and the three loading conditions: a measure of posterolateral translation (a, b), medial/lateral translation (c, g), a measure of anterior-posterior translation (f), a ratio of anterior-posterior translation (d/e), an angle (Angle 1) created by a line parallel to the incisura and the axis of the fibula, and an angle (Angle 2) created between the medial surfaces of two malleoli. These measurements have all been previously described. Each measurement was taken at baseline and compared with the three loading scenarios. A repeated measures ANOVA with a Bonferroni correction for multiple comparisons was used to test for significance.

**Results:** Significant lateral (g, maximum 5.26 mm), posterior (f, maximum 6.42 mm), and external rotation (angle 2, maximum 11.71°) was noted with the 4 kg repair when compared to the intact, loaded state. Significant posterior translation was also seen with the both the 8 kg and 12 kg repairs, however the incidence and magnitude was less than with the 4 kg repair. Significant overcompression (g, 1.69 mm) was noted with the 12 kg repair.
**Conclusion:** Suture button constructs must be appropriately tensioned to maintain reduction and re-approximate the degree of physiological motion at the distal tibiofibular joint. If inserted too loosely, these constructs allow for supraphysiologic motion which may have negative implications on ligament healing. These constructs also demonstrate overcompression of the syndesmosis when inserted at maximal tension however the clinical effect of this remains to be determined.

**32 - Does Primary Wound Closure following Open Fracture affect Development of Deep Infection or Non-union? A Prospective Cohort Study of 83 Subjects with 84 Open Fractures**

**Angela Scharfenberger, AB; Khaled Alabbasi, AB; Stephanie Smith, AB; Don Weber, AB; Sukhdeep Dulai, AB; Joseph Bergman, AB; Lauren Beaupre, AB**

**Purpose:** The primary purpose was to determine the incidence of deep infection or non-union following primary closure of open fractures. Secondarily, a matched series analysis compared these outcomes with subjects who had undergone delayed closure after an open fracture in a previous cohort study. We hypothesized that primary closure would not adversely affect outcomes.

**Method:** Between 2009 and 2013, 83 subjects with 84 open fractures who underwent primary wound closure were enrolled prospectively at a Level One trauma centre and followed for one year. Primary wound closure was performed when the Gustilo Grade was Grade three A or lower and the wound was deemed clean at time of initial surgery. Demographics and injury information were recorded. Subjects were evaluated postoperatively using standardized data forms until the fracture(s) healed. Phone interviews and chart reviews were undertaken at one year post-fracture. These subjects were matched on age, gender, fracture location and Gustilo grade to a previous prospective cohort of subjects with open fractures treated with delayed closure, undertaken between 2001 and 2009 at the same centre with similar selection criteria and study procedures. Outcomes were blinded at time of case matching. Non-union was defined as unplanned surgical intervention after definitive wound closure or incomplete radiographic healing one-year post fracture. Deep infection was defined as infection requiring unplanned surgical debridement and/or sustained antibiotic therapy following wound closure. Descriptive analyses were undertaken on the primary closure cohort to examine outcomes. Matched analysis was undertaken on 68 pairs of subjects who were matched on all four variables. Un-matched subjects (n=16[19%]) were more likely to be older (p<0.001) females (p=0.009) with lower grade Gustilo (p=0.009) upper extremity fractures (p=0.009). There was no difference in union or infection outcomes between matched and un-matched subjects (p=1.0).

**Results:** The majority (n=52[62%]) were males and the mean age was 47.2±21.0 years. Motor vehicle accidents were most common (n=38[49%]), followed by falls (n=34[42%]), crush injuries (n=6[7%]) and assaults (n=6[7%]). Fracture distribution was similar among upper extremity (n=36[43 %]) and tibia/fibula (n=413[52%]) fractures while femur fractures were less common (n=10[12%]). The one year follow-up was completed by 82(99%) subjects. Overall, nine (11%) primary closure subjects developed non-union while three (4%) subjects had deep infections. In the matched analyses of 68 pairs (136 subjects), mechanism of injury and associated injuries were similar (p>0.36) as well as the median time to operative management (p=0.34). Overall, there were more non-unions (n=19[29%]) and deep
Infections (n=6 [9%]) reported in the delayed closure cohort than in the primary closure cohort (p <0.001 for both; McNemar test for matched data).

**Conclusion:** In patients with lower-mid Gustilo grade open fractures and wounds deemed clean at initial surgery, primary wound closure does not appear to increase the risk of either deep infection or non-union compared to delayed wound closure. Further work is required to determine if primary wound closure reduces the risk for non-unions and/or infections after open fracture.

**33 - Assessing Osteoporosis Management of Fragility Fracture Patients in Cast Clinic**

**Natalie Rollick, AB; Robert Korley, AB; Richard B Buckley, AB; Paul Duffy, AB; Ryan Martin, AB; Prism S. Schneider, AB**

**Purpose:** Orthopaedic surgeons frequently assess fragility fractures (FF), however osteoporosis (OP) is often managed by primary care physicians (PCP). Up to 48% of FF patients have had a previous fracture (Kanis et al., 2004). Discontinuity between fracture care and OP management is a missed opportunity to reduce repeat fractures. This study aimed to evaluate current OP management in FF patients presenting to cast clinic.

**Method:** A single centre, prospective observational study where seven traumatologists screened for FF in cast clinic. FF was defined as a hip, distal radius (DR), proximal humerus (PH), or ankle fracture due to a ground level fall. Patients completed a self-administered questionnaire for demographics, fracture type and treatment, medical and fracture history, and previous OP care. The primary outcome was number of FF patients who received OP investigation and/or treatment. Secondary outcomes included Fracture Risk Assessment Tool (FRAX), repeat fracture rate, and anti-resorptive related fractures. Descriptive statistics were used for analysis.

**Results:** Between November 17, 2014 and October 13, 2015, a total of 1,677 patients attended cast clinic for an initial assessment. FF were identified in 120 patients (7.2%). The FF cohort had a mean age of 65.3 (± 14.3) years, mean BMI of 26.1 (± 5.3), and was comprised of 83.3% females. Fracture distribution was 69 (57.5%) DR, 23 (19%) ankle, 20 (16.5%) PH, and seven (5.8%) hip fractures, with 24 of the FF (19.8%) treated operatively. Thirteen (10.8%) were current smokers and 40 (33.3%) formerly smoked. A history of steroid use was present in 13 patients (10.8%). Ninety (n = 117; 76.9%) of patients ambulated independently. Twenty-two patients (18.3%) reported prior diagnosis of OP, most often by a PCP (n = 19; 73.7%) over 5 years previously. Calcium (n = 59; 49.2%) and Vitamin D (n = 70; 58.3%) were common and 26 patients (21.5%) had a prior anti-resorptive therapy, with Alendronate (n = 9) being most common. One patient had an anti-resorptive-related fracture. Raloxifene was used in ten patients. Forty-seven patients (39.2%) had a prior fracture at a mean age of 61.3 (± 11.9) years, with DR and PH fractures being most common. Eleven patients had two or more prior fractures. A family history of OP was found in 34 patients (28.1%). Mean FRAX score was 20.8% (± 10.8%) 10-year major fracture risk and 5.9% (± 6.6%) 10-year hip fracture risk (n = 30 bone densitometry within one-year). Of the 26 patients with a Moderate (10-20%) or High (> 20%) 10-year major fracture risk, only eight (30.8%) reported a diagnosis of OP and only three (11.5%) had seen an OP specialist.
Conclusion: Cast clinics provide an opportunity for OP screening, initiation of treatment, and patient education. This cohort demonstrated a high rate of repeat fractures and poor patient reporting of prior OP diagnosis. This study likely underestimated FF and calls for resource allocation for quantifying true burden of disease and outpatient fracture liaison service.

34 - Fixation of Anteromedial Coronoid Facet Fractures: Locking vs Non-locking vs Screw Constructs

John Morellato, ON; William Desloges, ON; Hakim Louati, ON; Steven Papp, ON; J W Pollock, ON

Purpose: Fractures of the anteromedial facet (AO/OTA 21-B1.1, O'Driscoll Type 2, subtype 3) are associated with varus posteromedial rotational instability of the ulnohumeral joint and early post-traumatic arthritis. The purpose of this study was to examine the stability of plate (locking and non-locking) vs screw constructs in the fixation of anteromedial coronoid facet fractures in a sawbone model.

Method: An anteromedial coronoid facet fracture (AO/OTA 21-B1.1) was simulated in 24 synthetic ulna bones. They were then assigned into 3 fracture fixation groups: non-locking plate fixation, locking plate fixation, and dual cortical screw fixation. An AO 2.0 mm screw and plate system was used for the plate fixation groups and 2.0 mm cortical screws were used for the screw-only group. Following fixation, each construct was cycled in tension and then in compression at 0.5Hz. For both cycling modalities, an incremental loading pattern was used starting at 40 N and increased by 20 N every 200 cycles up to 200N. Fracture fragment displacement was recorded with an optical tracking system. Following cyclic loading each construct was loaded to failure (displacement >2 mm) at 10mm/min.

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

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

Failure Testing - The maximum load at failure in the screw-only group (281.9 N) was significantly lower than locking and non-locking constructs (587.0 N and 515.5N respectively, p <0.05). There was no difference between the locking and non-locking group in mean load to failure or mean stiffness. Screw construct stiffness (337.2 N/mm) was lower than the locking and non-locking constructs (682.9 N/mm and 479.1 N/mm respectively) however this did not reach statistical significance (p=0.051).

Conclusion: Fixation of anteromedial coronoid fractures is best achieved with a plating technique. Locking plates did not offer any advantage over conventional plates. Isolated screw fixation might not
provide adequate stability for these fractures which could result in loss of reduction leading to post-traumatic arthrosis or instability.

35 - Medial Plating of Pilon Fractures as Predictor of Soft Tissue Complications
Ted Tufescu, MB; Mohammed Alshehri, Saudi Arabia

**Purpose:** Pilon fractures are associated with significant soft tissue injury, as well as soft tissue complications. The soft tissue on the medial side of the distal tibia is often involved, likely due to a lack of muscle investment. Medial approaches and medial plate application may well add to the soft tissue trauma. The objective of this study was to examine the relationship between medial plating and soft tissue complications in our center.

**Method:** This is a retrospective study based on a prospective database. Pilon cases treated with plate and screw fixation were identified between 2011 and 2014. Injury characteristics, patient demographics, and soft tissue complications were collected from chart review. Soft tissue complications recorded included any wound or skin problem, as well as patient complaints of hardware irritation leading to hardware removal. Logistic regression was employed. Independent variables for the model included medial plating, the presence of open fracture, smoking status and diagnosis of diabetes. Two models were created, one with the dependent variable as presence of any soft tissue complication, and the second model with the dependent variable as presence of a wound complication, which required surgical intervention.

**Results:** The study included 91 patients, 89 of whom had full data with an average follow up of 11.6 months (1-33 months). The incidence of soft tissue complications, including hardware irritation, was 26% (n=23), and 13% (n=12) required surgical treatment. Smoking status was the only predictor of soft tissue complications with an odds ratio of 3.6 (95%CI 1.2, 10.4; p=0.02), while controlling for other independent variables. The model explained 12% of the variation in soft tissue complications (Cox and Snell 0.119, p=0.028). In the second model, presence of a medial plate predicted soft tissue complications requiring surgical intervention with an odds ratio of 8.8 (95%CI 1.1, 73.7; p=0.045), while controlling for the other independent variables. The model explained 10% of the variation in soft tissue complications requiring surgical intervention (Cox and Snell 0.095, p=0.035).

**Conclusion:** The use of a medial plate does not appear to correlate to general soft tissue complications in pilon fractures. Smoking status increased the odds of a soft tissue complication more than three fold. The use of medial plating did increase the odds of soft tissue complications that required surgical treatment almost nine fold. It appears medial plating is not related to soft tissue complications, however treating soft tissue compilations in the presence of a medial plate may require more invasive methods.
**Paper Session:** COA Tumour

**36 - Direct Intra-tumour Delivery of Zoledronate is Superior to Systemic Administration for Mitigating Metastasis-induced Bone Destruction**

Anas Nooh, QC; Yu Ling Zhang, QC; Daisuke Sato, QC; Zhifeng Dong, QC; Peter Siegel, QC; Jake Barralet, QC; Michael Weber, QC

**Purpose:** Bone metastases are the most common cause of cancer-related pain and often lead to other complications such as pathological fractures and spinal cord compression. Bisphosphonates (BP) are a class of potent anti-resorptive agents commonly prescribed to retard osteoporosis progression. Interestingly, BP may have indirect anti-tumor properties through negative effects on macrophages, osteoclasts, endothelial cells and their ability to suppress matrix metalloproteinase (MMP) activity. Currently, the use of bisphosphonates for cancer therapy is generally restricted to high dose systemic delivery. The purpose of this study was to investigate the effects of direct local delivery of Zoledronate at the metastatic site in a mouse model of breast cancer metastasis to bone.

**Method:** Seven days following intra-tibial inoculation with MDA-MB-231 (N = 1×10⁵) breast cancer cells in athymic mice, the experimental group (N = 11) was treated by direct infusion of 2µg of Zoledronate into the tibial lesion (three times/week for three weeks) and compared to vehicle-treated mice (N = 5). The formation of bone metastases and growth of the lesions were followed up by weekly bioluminescence imaging. In a subsequent experiment, a comparison of the effects of local versus systemic delivery of Zoledronate on the formation of osteolytic bone metastases was carried in athymic mice (N = 15). Seven days following intra-tibial inoculation with MDA-MB-231 breast cancer cells, the systemic group (N = 5) was treated with Zoledronate (0.025mg/kg) once per week for four weeks and compared to systemic delivery of vehicle (N = 4). Following treatment, the mice were sacrificed, and micro-CT images of the right tibia were obtained. Bone volume to tissue volume ratio (BV/TV%) was determined using µ-CT biomarkers.

**Results:** The first experiment showed a statistically significant increase in mean bone volume/tissue volume ratio% (BV/TV%) in the treated group (7.0±1.54%) as compared to the control group (3.8±0.48%) (P <0.001, 95%CI=1.9-4.3). This corresponded to a net increase of 84.21% in response to Zoledronate treatment. Comparison between the local and systemic effects of Zoledronate also revealed a significant increase in the BV/TV% in the locally treated group (6.69±0.62%) when compared to the cohort administered systemic bisphosphonate treatment (4.03±0.44%) (P<0.001, 95%CI=1.24-3.20), corresponding to a net increase of 66.0%.

**Conclusion:** These preliminary results suggest that high dose sustained release of Zoledronate can lead to a significant inhibition of tumor-induced osteolysis. Moreover, comparison between local and systemic delivery revealed that the effect of local bisphosphonate administration exceeds the benefits of systemic delivery in terms of osteolysis inhibition. Lastly, the noted effects of Zoledronate local delivery triggers the need for further assessment of its anti-tumor activity.

**37 - Outcome and Complications Following Free Fibula Reconstruction for Resection of a Malignant Process in the Extremities**
Matthew Thomas Houdek, US; Peter S Rose, US; Steven L Moran, US; Franklin H Sim, US

Purpose: Following tumor resection, reconstructive surgeons are often left with large composite bone and soft tissue defects in a physiological poor host. In order to achieve limb salvage and provide the patient with a functional extremity, vascularized bone transfer, namely free fibula transfer, has become the work-horse for reconstruction. In the traumatic setting the use of these flaps has been reliable, however, due to the various host factors the use of vascularized bone transfer has associated with a high complication rate following oncological reconstruction. The aim of this study was to review our institution’s experience with the use of free fibula reconstruction following an oncological resection in the extremities affecting 1) overall survivorship, 2) disease specific survival, both local recurrence and distant disease, 3) union of the fibula and 4) postoperative complications including limb salvage.

Method: We retrospectively reviewed the records of 56 cases of free fibula transfer performed for limb salvage following an oncological resection from 1994 and 2013. Pertinent demographics as well as information regarding the surgical procedure and disease status at latest follow-up were reviewed. Disease free survival and overall survival were estimated using Kaplan Meier method. The cohort consisted of 30 males and 26 females; with a mean age at surgery of 19 years and a mean follow-up of 7 years. 63% of the tumors were located in the lower extremity.

Results: The overall 2-, 5-, 10- and 15-year survival was 98%, 86%, 73% and 73%. In an analysis of risk factors for mortality, failure of limb salvage and tumor recurrence was associated with a worse overall survival. In regards to disease specific survival, the overall 2-, 5-, and 10-year survival was 82%, 75%, 67% and 50%. No analyzed factor was associated with a worse disease specific survival. In regards to union of the fibula graft, first time union was observed in 75% of cases at a mean time to union of 10 months. 25% of patients required an additional autologous bone grafting procedure. The overall union rate was 98%, with 2 patients requiring a revision of the fibula graft with a new free vascularized bone graft. Patients undergoing chemotherapy following the free-fibula graft were more likely (HR 2.10, P=0.03) to fail first time bone grafting. The overall rate of limb salvage was 93%, with 4 patients requiring an amputation for local tumor recurrence (n=3) and infection (n=1). In addition to these amputations, postoperative complications occurred in 25 patients. These complications included fracture (n=11), infection (n=5), nerve palsy (n=3) and compartment syndrome (n=2).

Conclusion: The free-fibula is considered the work horse vascularized bone graft for extremity reconstruction in limb-salvage surgery. In the oncological setting a repeat bone grafting procedure was common, and likely related to the patient undergoing chemotherapy, however following this procedure the fibula reliably heals.

38 - Intercalary Allograft Augmented with Intramedullary Cement and Plate Fixation – A Reliable Solution After Tumour Resection
Sanjay Gupta, ON; Lisa Kafchinski, ON; Kenneth Gundle, ON; Kevan Saidi, ON; Anthony Griffin, ON; Peter Ferguson, ON; Jay Wunder, ON

Purpose: Biological reconstruction techniques after diaphyseal tumour resection have increased in popularity in recent years. High complication and failure rates have been reported with intercalary
allografts, with recent studies questioning their role in limb-salvage surgery. We developed a technique in which large segment allografts are augmented with intramedullary cement and fixed using compression plating. The goal of this study was to evaluate the survivorship, complications and functional outcomes of these intercalary reconstructions.

**Method:** Forty-two patients who had reconstruction with an intercalary allograft following tumour resection between 1989 and 2010 were identified from our prospectively collected database. Allograft survival, local recurrence-free, disease-free and overall survival were assessed using the Kaplan-Meier method. Patient function was assessed using the Musculoskeletal Tumor Society (MSTS) scoring system and the Toronto Extremity Salvage Score (TESS).

**Results:** The 23 women and 19 men had a mean age of 33 years (14-77). The most common diagnoses were osteosarcoma (n=16) and chondrosarcoma (n=9). There were 9 humerus, 18 femur and 15 tibia reconstructions. At a mean follow-up of 95 months (5-288), 31 patients were alive without disease, 10 were dead of disease and 1 was deceased of other causes. There were 4 local recurrences and 11 patients developed metastatic disease. 5-year local recurrence free survival was 92%, 5-year disease-free survival was 70% and overall survival was 75%. Fourteen of 42 patients (33%) experienced complications: 5 wound healing complications, 4 infections, 2 non-unions, 2 fractures and 1 nerve palsy. Four allografts (9.5%) were revised for complications and 2 (5%) for local recurrence. Mean allograft survival was 85 months (4-288). Mean time to union was 8.2 (3-36) months for the proximal osteotomy site and 8.1 (3-23) months for the distal osteotomy site. The mean score for MSTS 87 was 29.4 (+/- 4.4), MSTS 93 was 83.7 (+/-14.8) and TESS was 81.6 (+/-16.9).

**Conclusion:** An intercalary allograft augmented with intramedullary cement and compression plate fixation provides a reliable and durable method of reconstruction after tumour resection. Complication rates are comparable to the literature and are associated with high levels of patient function and satisfaction.

**39 - Analysis of Referral Patterns In Orthopaedic Oncology**

**Alexis Rousseau-Saine, QC; Felix Brassard III, QC; Janie Barry M.Sc, QC; Hugo St-Yves M.Sc, QC; Marc Isler, QC; Sophie Mottard, QC**

**Purpose:** Musculoskeletal tumours are relatively rare and as such, they are not well known by the population and by general practitioners. We observed that an important proportion of our patients has seen major delays at different stages of their referral pathway. It is well recognised that such delays can cause avoidable loss of function, local and systemic recurrence and increase in health system costs. The main objective of this study was to prospectively assess the referral patterns of our patients to pinpoint the causes of the delays. This should allow the formation of strategies to minimise delas and their impact. The secondary objective was to assess the performance of our center in comparaison to other center with the goal of improving quality of care.

**Method:** Prospective follow up data is available for 457 patient referred to our musculoskeletal oncology team between july 2011 and november 2014. Every patients filled questionnaires on their
initial referral patterns. Site specific function and quality of life are evaluated at baseline and at subsequent follow-up (six months, one year, three years and five years).

**Results:** The average delay between the first symptoms and the first medical consultation with a general practitioner was 37 weeks (CI: 27-46). The average delay between the first medical consultation and the referral to orthopaedic oncology was 54 weeks (CI: 43-65). The delay between the first consultation with a general practitioner and the first radiologic test was 31 weeks (CI: 22-39). The delay between the first radiologic test and the referral to orthopaedic oncology was 28 weeks (CI 24-32). The delay between the referral to orthopaedic oncology and the first appointment to our center was three weeks (CI 2-4). Before the referral to our center, 23% of the patients met two general practitioners and 10% met with 3 or more general practitioner. Fifty-two percent of the patients had a consultation with a specialist and 19% saw two or more specialists.

**Conclusion:** It is imperative to raise awareness of musculoskeletal tumors and indication for early referral in general practitioners. One of the main problems in our actual referral pattern is early access to appropriate imaging. The creation of a referral program with specific guidelines is, in our opinion, the best way to significantly reduce the delays for appropriate management of patients with suspicion of musculoskeletal tumors.

**40 - Early Assessment of Lung Metastasis Risk in Soft-tissue Sarcomas: Prediction of Prospective Cohort and Potential Improvement Using Hypoxia and Perfusion Biomarkers**

**Martin Vallières, QC; Carolyn R Freeman, QC; Ahmed Zaki, QC; Robert Turcotte, QC; Mark Hickeson, QC; Sonia Skamene, QC; Krishinima Jeyaseelan, QC; Lara Hathout, QC; Monica Serban, QC; Shu Xing, QC; Tom I Powell, QC; Krista Goulding, QC; Jan Seuntjens, QC; Ives R Levesque, QC; Issam Issam El Naqa, QC**

**Comments:** This is a quite innovative study should lead to a multicentre validation trial.

**Purpose:** We have developed an FDG-PET/MRI texture-based model for the prediction of lung metastases (LM) in newly diagnosed patients with soft-tissue sarcomas (STSs) using retrospective analysis. In this work, we assess the model performance using a new prospective STS cohort. We also investigate whether incorporating hypoxia and perfusion biomarkers derived from FMISO-PET and DCE-MRI scans can further enhance the predictive power of the model.

**Method:** A total of 66 patients with histologically confirmed STSs were used in this study and divided into two groups: a retrospective cohort of 51 patients (19 LM) used for training the model, and a prospective cohort of 15 patients (two patients with LM, one patient with bone metastases and suspicious lung nodules) for testing the model. In the training phase, a model of four texture features characterizing tumor sub-region size and intensity heterogeneities was developed for LM prediction from pre-treatment FDG-PET and MRI scans (T1-weighted, T2-weighted with fat saturation) of the retrospective cohort, using imbalance-adjusted bootstrap statistical resampling and logistic regression multivariable modeling. In the testing phase, this multivariable model was applied to predict the distant metastasis status of the prospective cohort. The predictive power of the obtained model response was assessed using the area under the receiver-operating characteristic curve (AUC). In the exploratory phase of the study, we extracted two heterogeneity metrics from the prospective cohort: the area under
the intensity-volume histogram of pre-treatment DCE-MRI volume transfer constant parametric maps and FMISO-PET hypoxia maps (AU-IVH-Ktrans, AU-IVH-FMISO). The impact of the addition of these two individual metrics to the texture-based model response obtained in the testing phase was first investigated using Spearman's correlation (rs), and lastly using logistic regression and leave-one-out cross-validation (LOO-CV) to account for overfitting bias.

**Results:** First, the texture-based model reached an AUC of 0.94, a sensitivity of 1, a specificity of 0.83 and an accuracy of 0.87 when tested in the prospective cohort. In the exploratory phase, the addition of AU-IVH-FMISO did not improve predictive power, yielding a correlation of rs = -0.42 (p = 0.12) with lung metastases, and a relative change in validation AUC of 0 % in comparison with the texture-based model response alone in LOO-CV experiments. In contrast, the addition of AU-IVH-Ktrans improved predictive power, yielding a correlation of rs = -0.54 (p = 0.04) with lung metastases, and a change in validation AUC of +10 %.

**Conclusion:** Our results demonstrate that texture-based models extracted from pre-treatment FDG-PET and MRI anatomical scans could be successfully used to predict distant metastases in STS cancer. Our results also suggest that the addition of perfusion heterogeneity metrics may contribute to improving model prediction performance.

41 - Disease Progression and Survival in Patients with Metastatic Soft Tissue Sarcoma Treated with Palliative Chemotherapy

**Coralie Laflamme, QC; Sophie Mottard, QC; Jean-Luc Dionne, QC; Marc Isler, QC; Imran Ahmad, QC**

**Purpose:** High grade sarcoma present a systemic metastatic progression in approximately 50% of cases. The effectiveness of palliative chemotherapy as a treatment of systemic metastases is still controversial. The main objective of this study is to assess disease progression and survival of patients diagnosed with metastatic soft tissue sarcomas treated with palliative chemotherapy, analyse chemotherapy treatment patterns and response to different lines of treatment.

**Method:** Retrospective chart review of 75 patients treated with palliative chemotherapy for metastatic soft tissue sarcomas between 2003 and 2013 at Maisonneuve-Rosemont Hospital. Data for control group of 40 patients with metastatic soft tissue sarcomas not treated with chemotherapy was collected retrospectively. Collected data include demographic data, overall survival, time free survival, type of chemotherapy treatment, surgical treatment and adverse reaction to palliative chemotherapy. Overall survival was analyzed with Kaplan-Meier test. Categorial variable were compared with Log-Rank test

**Results:** Seventy-five patients (37 % female; mean age 50.4 years) received minimally one line of chemotherapy for their metastatic sarcomas. The regimens most commonly used in first-line were doxorubicin (48 %) and doxorubicin combined with ifosfamide (21.3 %). Favorable response was achieved by 38.7 % in first-line and 27.9% in second-line therapy. Median overall survival with chemotherapy treatments was more than two times overall survival without treatments. Median overall survival was 19 months with chemotherapy treatments and 7 months without chemotherapy (p<0.0001). There was no statistically significant difference between survivals for treated and untreated patients with chemotherapy when analyzed in term of the histological subtype, age and monotherapy
versus combined treatment. Event-free survival was statistically longer during the first year for the group of patients treated with combined chemotherapy (p=0.0125).

**Conclusion:** Results have shown a significantly improved overall survival in all histological groups, resulting in an OS of 19 vs 7 months for the chemotherapy and non chemotherapy group respectively. Nevertheless, patients with favorable response to chemotherapy have poor outcomes. Additional treatment options are needed.

**42 - Oncologic and Functional Outcome after Hindquarter Resections for Sarcoma: Is it Worth it?**

Anthony M Griffin, ON; Winan J. van Houdt, Netherlands; Jay S Wunder, ON; Peter C Ferguson, ON

**Purpose:** Hindquarter amputations for bone or soft tissue sarcoma cause a high degree of disability in patients and are associated with high morbidity rates. The goal of this study is to determine prognostic factors for outcome and analyze quality of life after resection, in order to better select patients who are more likely to benefit from a hindquarter amputation.

**Method:** Our prospectively collected database was searched for all patients treated with a hindquarter amputation between 1989 and 2015. Clinical and histopathological features were analyzed for their prognostic value using Kaplan-Meier and Cox proportional hazard analysis. Endpoints were set at recurrent disease and death. Also, functional and social outcome as well as pain was assessed from the hospital charts in the patients that are still alive.

**Results:** 82 patients underwent a hindquarter resection in the given time frame. Of these patients, 63 were treated with a curative intent. The median hospital stay was 25 days, and 49% of the patients had wound complications. The in-hospital mortality was 6%. The 5-year overall survival in the whole group was 31%, while disease free survival was 26%. As expected, patients with metastases at presentation had a significantly worse outcome, while patients with locally recurrent sarcoma had the same outcome as patients with primary sarcoma. For those patients treated with curative intent, younger age was correlated with better survival, while higher histological grade was correlated with worse disease free survival. The functional and social outcome for patients who survived more than one year varied widely, with about 50% of the patients living an acceptable social life with reasonable pain levels and mobility status.

**Conclusion:** Hindquarter amputations for sarcoma patients are still indicated for a select group of patients. Younger patients and/or patients with low grade sarcomas are more likely to benefit from this resection in terms of survival and long term function. However, for patients with less favourable prognostic factors a hindquarter operation might be an unreasonable palliative option.

**43 - Major Wound Complication Risk Factors Following Soft Tissue Sarcoma Resection**

James Moore II, QC; Sophie Mottard, QC; Marc Isler, QC; Janie Barry, QC

**Comments:** Cette étude a mené à l’article suivant : Major wound complication risk factors following soft tissue sarcoma resection.
Purpose: Wound-healing complications represent an important source of morbidity in patients treated surgically for soft tissue sarcomas (STS). The purpose of this study was to determine which factors are predictive of major wound complication rates following STS resection, including tumor site, size, grade, and depth, as well as radiotherapy and chemotherapy.

Method: We reviewed 256 cases of STS treated surgically between 2000 and 2011. The primary outcome was occurrence of major wound complications post STS resection.

Results: Major wound complications were more likely to occur post STS resection with larger tumor diameters ($p = 0.001$), high grade tumors ($p = 0.04$), location in the proximal lower extremity ($p = 0.01$), and use of preoperative radiotherapy ($p = 0.01$). Tumors located in the adductor compartment were at highest risk of complications. We did not demonstrate a significant difference in complications rates based on method of closure. Diabetes, smoking, obesity, tumor location in the proximal lower extremity, and preoperative radiotherapy were independent predictors on multivariate analysis.

Conclusion: There are multiple predictors for major wound complications post STS resection. A more aggressive resection of irradiated soft tissues, combined with primary reconstruction, should be considered in cases with multiple risk factors.

44 - Evidence Over Time: Has the MSTS Moved Towards Higher Level of Evidence?
Patrick Thornley, ON; Daniel M Lerman, US; Matthew Cable, US; Nathan Evaniew, ON; Gerard Slobogean, US; Mohit Bhandari, ON; John Healey, NY; R. Lor Randall, US; Michelle Ghert, ON

Purpose: Level of evidence (LOE) determination is a reliable tool to assess the strength of research based on study design. Improvements in LOE are necessary for the advancement of evidence-based clinical care. The objectives of this study were to determine if the LOE presented at the Musculoskeletal Tumor Society (MSTS) annual meeting has improved over time and to determine how the LOE presented at MSTS annual meetings compares to that of the Orthopaedic Trauma Association (OTA) annual meetings.

Method: We reviewed abstracts from the MSTS and OTA annual meeting podium presentations from 2005 to 2014. Three independent reviewers evaluated a total of 1222 abstracts for study type and LOE. Changes in the distributions of study type and LOE over time were evaluated by Pearson Chi-Squared test.

Results: There were a total of 577 podium abstracts from the MSTS and 645 from the OTA. Of the MSTS therapeutic studies, 0.5% (2/376) were level I, while 75% (281/376) were level IV. There was a sevenfold higher proportion of level I studies (3.4% [14/409]) and less than half as many level IV studies (32% [130/409]) presented at OTA. There was no improvement in the MSTS LOE for all study types ($p=0.13$) and therapeutic study types ($p=0.36$) over the study decade. In contrast, the OTA LOE increased significantly over this time period for all study types ($p<0.01$). The proportion of controlled therapeutic studies (LOE I through III) versus uncontrolled studies (LOE IV) increased significantly over time at the OTA ($p<0.021$), but not at the MSTS ($p=0.10$).
Conclusion: Uncontrolled case series continue to dominate the MSTS scientific program, whereas over the past decade, higher-level studies and more modern study methodology has been employed by members of the OTA.

45 - Predictors of Blood Transfusion and Wound Infection Following Surgical Resection of Soft Tissue Sarcoma: Analysis of 788 Patients in ACS-NSQIP Database
Anas Nooh, QC; Robert Turcotte, QC; Krista Goulding, QC

Purpose: Wound complications are common in patients with soft tissue sarcomas (STS) treated with surgical excision. Limited data is available on predictive factors for wound complications beyond the relationship to neo-adjuvant or adjuvant radiotherapy. Likewise, the association between blood transfusion, patient comorbidities and post-operative outcomes is not well described. In the present study we identified the predictive factors for blood transfusion and wound complications in patients undergoing surgical resection of soft tissue sarcoma from a national cohort.

Method: The American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database was used to identify patients who underwent surgical resection of a STS from 2005 to 2013. Primary malignant soft tissue neoplasms were identified using the following ICD-9 codes: 171.2, 171.3 and 171.6. Patients treated with both wide excision and amputation were identified using the current procedural terminology (CPT) codes. Prolonged operative time was defined as greater than 90th percentile of time required per procedure. A multivariable logistic regression model was used to identify associations between patient factors and post-operative wound complications (superficial and deep surgical site infections (SSI), and wound dehiscence). A similar regression model sought to identify prognostic factors for blood transfusion and associations with post-operative outcomes.

Results: A total of 788 patients met our inclusion criteria. Of these, 64.2% had tumors in the lower limb, 23.1% patients had tumors in the upper limb, and 12.7% patients had pelvic tumors. Six hundred and forty patients (81.2%) underwent surgical excision; 148 (18.8%) patients had an amputation. Multivariable logistic regression modeling identified American Society of Anaesthesiologist (ASA) class 3 and 4 (OR=2.3, P=0.03; OR=8.3, P=0.001, respectively), amputation (OR=14.0, P<0.001) and prolonged operative time (OR=4.6, P<0.001) as significant predictors of blood transfusion. Radiotherapy (OR=2.6, P=0.01) and amputation (OR=2.6, P=0.01) were identified as predictors of superficial SSI, whereas ASA class 4 (OR=6.2, P=0.03), prolonged operative time (OR=3.9,P=0.012) and return to the operating room (OR=10.5, P<0.001) were associated with deep SSI. Male gender (OR=1.8, P=0.03), diabetes (OR=2.3, P=0.03), ASA class 3 (OR=2.4, P=0.003), amputation (OR=3.8, P<0.001) and steroids (OR=4.5, P=0.03) were identified as predictors for wound dehiscence and open SSI.

Conclusion: A national cohort demonstrates that male gender, diabetes, chronic steroid use, higher ASA score and radiotherapy are associated with an increased incidence of wound complications. One in twenty-three patients undergoing resection of an STS will require a blood transfusion, and this risk is correlated with amputation, prolonged operative time and increased ASA score. Strategies to decrease the risk of blood transfusion and wound complication should be considered for these patient groups.
**Paper Session:** CORS Joints and Arthritis

**46 - The Pathomorphology of Medial Knee OA**

*Anthony Leong, England; Andrew Amis, England; Jonathan Jeffers, England; Justin Cobb, England*

**Purpose:** Are there any patho-anatomical features that might predispose to primary knee OA? We investigated the 3D geometry of the load bearing zones of both distal femur and proximal tibias, in varus, straight and valgus knees. We then correlated these findings with the location of wear patches measured intra-operatively.

**Method:** Patients presenting with knee pain were recruited following ethics approval and consent. Hips, knees and ankles were CT-ed. Straight and Rosenberg weight bearing X-Rays were obtained. Excluded were: Ahlbäck grade “>1”, previous fractures, bone surgery, deformities, and any known secondary causes of OA. 72 knees were eligible. 3D models were constructed using Mimics (Materialise Inc, Belgium) and femurs oriented to a standard reference frame. Femoral condyle Extension Facets (EF) were outlined with the aid of gaussian curvature analysis, then best-fit spheres attached to the Extension, as well as Flexion Facets (FF). Resected tibial plateaus from surgery were collected and photographed, and Matlab combined the average tibia plateau wear pattern.

**Results:** Of the 72 knees (N=72), the mean age was 58, SD=11. 38 were male and 34 female. The average hip-knee-ankle (HKA) angle was 1° varus (SD=4°). Knees were assigned into three groups: valgus, straight or varus based on HKA angle. Root Mean Square (RMS) errors of the medial and lateral extension spheres were 0.4mm and 0.2mm respectively. EF sphere radii measurements were validated with Bland-Altman Plots showing good intra- and interobserver reliability (+/- 1.96 SD). The radii (mm) of the extension spheres were standardised to the medial FF sphere. Radii for the standardised medial EF sphere were as follows; Valgus (M=44.74mm, SD=7.89, n=11), Straight (M=44.63mm, SD=7.23, n=38), Varus (M=50.46mm, SD=8.14, n=23). Ratios of the Medial:Lateral EF Spheres were calculated for the three groups: Valgus (M=1.35, SD=.25, n=11), Straight (M=1.38, SD=.23, n=38), Varus (M=1.6, SD=.38, n=23) . Data was analysed with a MANOVA, ANOVA and Fisher's pairwise LSD in SPSS ver 22, reducing the chance of type 1 error. The varus knees extension facets were significantly flatter with a larger radius than the straight or valgus group( p=0.004 and p=0.033) respectively. In the axial view, the medial extension facet centers appear to overlie the tibial wear patch exactly, commonly in the antero-medial aspect of the medial tibial plateau.

**Conclusion:** For the first time, we have characterised the extension facets of the femoral condyles reliably. Varus knees have a flatter medial EF even before the onset of bony attrition. A flatter EF might lead to menisci extrusion in full extension, and early menisci failure. In addition, the spherical center of the EF exactly overlies the wear patch on the antero-medial portion of the tibia plateau, suggesting that a flatter medial extension facet may be causally related to the generation of early primary OA in varus knees.

**47 - Secretory Profile of Bone Marrow Derived Mesenchymal Stromal Cells in Early and End-stage Knee OA Synovial Fluid**
Rajiv Gandhi, ON; Anirudh Sharma, ON; Penney M. Gilbert, ON; Mohsen Afshar Bakooshli, ON; Alejandro Gomez, ON; Mohit Kapoor, ON; Sowmya Viswanathan, ON

Purpose: Osteoarthritis (OA) is the most common form of arthritis worldwide. It is a major cause of disability in the adult population with its prevalence expected to increase dramatically over the next 20 years. Although current therapies can alleviate symptoms and improve function in early course of the disease, OA inevitably progresses to end-stage disease requiring total joint arthroplasty. Mesenchymal stromal cells (MSCs) have emerged as a candidate cell type with great potential for intra-articular (IA) repair therapy. However, there is still a considerable lack of knowledge concerning their behaviour, biology and therapeutic effects. To start addressing this, we explored the secretory profile of bone marrow derived MSCs in early and end-stage knee OA synovial fluid (SF).

Method: Subjects were recruited and categorized into early [Kellgren-Lawrence (KL) grade I and II, n=12] and end-stage (KL grade III and IV, n=11) knee OA groups. The SF proteome of early and end-stage OA was tested before and three days after the addition of bone marrow MSCs (16.5x10^3, single donor) using multiplex ELISA (64 cytokines) and mass spectrometry (302 proteins detected). Non parametric Wilcoxon-signed rank test for paired samples was used to compare the levels of proteins before and after addition of MSCs in early and end-stage knee OA SF. Significant differences were determined after multiple comparisons correction (FDR) with a p<0.05.

Results: Gender distribution and BMI were not statistically different between the two cohorts (p>0.05). However, patients in early knee OA cohort were significantly younger (44.7 years, SD=7.1) than patients in the end-stage cohort (58.6 years, SD=4.4; p<0.05). In both early and end-stage knee OA, MSCs increased the levels of VEGF-A (by 320.24 pg/mL), IL-6 (by 826.78 pg/mL) and IL-8 (by 128.85 pg/mL), factors involved in angiogenesis; CXCL1/2/3 (by 103.35 pg/mL), CCL2 (by 1187.27 pg/mL), CCL3 (by 15.82 pg/mL) and CCL7 (by 10.43 pg/mL), growth factors and chemokines. However, CXCL5 (by 48.61 pg/mL) levels increased only in early knee OA, whereas PDGF-AA (by 15.36 pg/mL) and CXCL12 (by 497.19 pg/mL) levels increased only in end-stage knee OA.

Conclusion: This study demonstrates that bone marrow derived MSCs secrete angiogenic and chemotactic factors both in early and end-stage knee OA. More importantly, MSCs show a differential reaction between early and end-stage OA. Functional assays are required to further understand on how the therapeutic effect of MSCs is modulated when exposed to OA SF.

48 - Adipokine Profile of Synovial Fluid in End-stage Knee Osteoarthritis – An Investigation Across Racial Groups

Anirudh Sharma, ON; Rajrishi Sharma, AB; Kala Sundararajan, ON; Anthony V. Perruccio, ON; Mohit Kapoor, ON; Rajiv Gandhi, ON

Purpose: In addition to mechanical stresses, an inflammatory mediated association between obesity and knee osteoarthritis (OA) is increasingly being recognized. Adipokines, such as adiponectin and leptin, have been postulated as likely mediators. Clinical and epidemiological differences in OA by race have been reported. What contributes to these differences is not well understood. In this study, we examined
the profile of adipokines in knee synovial fluid (SF) and the gene expression profile of the infra-patellar fat pad (IFP) by race among patients with end-stage knee OA scheduled for knee arthroplasty.

**Method:** Age, sex, weight and height (used to derive body mass index (BMI)) and race (White, Asian and Black) were elicited through self-report questionnaire prior to surgery. SF and IFP samples were collected at the time of surgery. Adipokines (adiponectin and leptin) were examined in the SF using MAGPIX Multiplex platform. IFP was profiled using Human Adipogenesis PCRArray and genes of interest were further validated via quantitative relative RT-PCR using Student’s t-test. Overall differences in adiponectin and leptin concentrations were tested across race. Linear regression modeling was used to investigate the association between adiponectin and leptin concentrations (outcomes) and race (predictor; referent group: White), adjusting for age, sex and BMI.

**Results:** 67 patients (18 White, 33 Asian, 16 Black) were included. Mean SF adiponectin concentration was greatest in Whites (1175.05 ng/mL), followed by Blacks (868.53 ng/mL) and Asians (702.23 ng/mL) (p=0.034). The mean SF leptin concentration was highest in Blacks (44.88 ng/mL), followed by Whites (29.86 ng/mL) and Asians (20.18 ng/mL) (p=0.021). Regression analysis showed Asians had significantly lower adiponectin concentrations compared to Whites (p<0.05). However, leptin concentrations did not differ significantly by race after adjusting for covariates. Testing of the IFP, using the Adipogenesis PCRArray, showed significant higher expression of LEP gene (leptin, p=0.03) in Asians (n=4) compared to Whites (n=4).

**Conclusion:** There appears to be important racial differences in the SF adiponectin profile among individuals with end-stage knee OA. Differential gene expression in the IFP across racial groups could be a potential contributory source for the noted SF variations. Further work to determine the source and function of adipokines in knee OA pathophysiology across racial groups is warranted.

**49 - A Short Novel Peptide for the Repair of Cartilage in Osteoarthritic Joints**

**Muhammad Albesher, QC;** Michael P Grant, QC; Laura M Epure, QC; Olga L Huk, QC; John Antoniou, QC; Fackson Mwale, QC

**Purpose:** Osteoarthritis (OA) is a multifactorial disease that affects millions of Canadians. Although, there is not one specific mechanism that causes OA, the biological outcome is cartilage degradation. The articular cartilage in joints is composed primarily of the proteoglycan aggrecan and type II collagen (Col II) which together provide cartilage with functional properties. In OA, the imbalance of the anabolic and catabolic activities of chondrocytes favors cartilage catalysis. The main inflammatory cytokine involved in cartilage degradation is interleukin (IL) 1β. It has previously been demonstrated that Link N, a 16 residue peptide derived from proteolytic cleavage of link protein, can stimulate matrix proteins in normal cartilage and intervertebral discs (IVDs). Recently, we showed that a shorter sequence of Link N (sLink N), consisting of the first 8 residues of the peptide, has the potential to increase synthesis of matrix proteins in IVD cells in vitro and stimulate repair in ex vivo IVD organ culture. There are currently no treatments that actively repair cartilage in OA joints. In the present study, we aimed to evaluate the potential of sLink N as a therapeutic agent in the repair of OA cartilage.
**Method:** OA cartilage was isolated from four donors undergoing total knee replacement (50–70 y). Cells were recovered from the cartilage of each knee by sequential digestion with Pronase followed by Collagenase, and expanded in PrimeGrowth culture medium (Wisent Bioproducts, Canada; Cat# 319-510-CL, -S1, and -S2). After 7 days in culture, cells were treated for 24h with sLink N (0.5, 5, 50, 500 or 5000 ng/ml) or sLink N in combination with IL-1β (1 ng/ml) to mimic an inflammatory milieu. Conditioned media was collected and measured for proteoglycan (GAG) release using the safranin O and for Coll II synthesis by Western blotting. Human articular cartilage explants including cartilage with subchondral bone were prepared from the same donors using the PrimeGrowth Isolation kit (Wisent, Canada) and cultured for 21 days in presence of IL-1β (1 ng/ml) and sLink N (0.5, 5, 50, 500 or 5000 ng/ml). Aggrecan and Coll II were extracted with guanidine buffer and measured by Western blotting.

**Results:** Treatment of OA chondrocytes significantly increased the GAG and Coll II synthesis. The EC50 dose-response of sLink N on GAG synthesis was 67 ± 41 nM [65 ± 40 ng/ml] and the GAG synthesis reached a maximum of 194 ± 30% with the highest dose above control. When chondrocytes were cultured in the presence of IL-1β, GAG synthesis was also elevated by sLink N above control. Treatment of OA cartilage explants with sLink N increased the content of aggrecan and Coll II even in the presence of IL-1β.

**Conclusion:** Our results suggest that sLink N is a growth factor supplement that can increase cartilage matrix protein synthesis, and a chondroprotective agent, by modulating the catabolic effects of IL-1β. sLink N is the first small-peptide to demonstrate potential in cartilage repair of OA joints.

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**50 - Platelet-rich Plasma Enhances Cartilage Integration: A Bioengineered in vitro Model**

Corey M Sermer, ON; Rita Kandel, ON; Mark Hurtig, ON; Jesse Anderson, ON; John Theodoropoulos, ON

**Purpose:** Osteoarthritis (OA) is a debilitating disease characterized by degradation of articular cartilage and subchondral bone remodeling. Current therapies for early or midstage disease do not regenerate articular cartilage, or fail to integrate the repair tissue with host tissue, and therefore there is great interest in developing biological approaches to cartilage repair. We have shown previously that platelet-rich plasma (PRP) can enhance cartilage tissue formation. PRP is obtained from a patient’s own blood, and is an autologous source of many growth factors and other molecules which may aid in healing. This raised the question as to whether PRP could enhance cartilage integration. We hypothesize that PRP will enhance integration of bioengineered cartilage with native cartilage.

**Method:** Chondrocytes were isolated from bovine metacarpal-phalangeal joints, seeded on a porous bone substitute (calcium polyphosphate) and grown in the presence of FBS to form an in vitro model of osteochondral-like tissue. After 7 days, the biphasic constructs were soaked in PRP for 30 minutes prior to implantation into the core of a ring-shaped biphasic explant of native bovine cartilage and bone. Controls were not soaked in PRP. The resulting implant-explant construct was cultured in a stirring bioreactor in serum free conditions for 2 weeks. The integration zone was visualized histologically. A push-out test was performed to assess the strength of integration. Matrix accumulation at the zone of integration was assessed biochemically and the gene expression of the cells in this region was assessed by RT-PCR. Significance (p<0.05) was assessed by a student’s t-test or one-way ANOVA with tukey’s post hoc.
Results: PRP soaked bioengineered implants, integrated with the host tissue in 73% of samples, whereas control bioengineered implants only integrated in 19% of samples based on macroscopic evaluation (p<0.05). The integration strength, as determined by the normalized maximum force to failure, was significantly increased in the PRP soaked implant group compared to controls (219 kPa and 72.0 kPa, respectively, p<0.05). This correlated with an increase in glycosaminoglycan and collagen accumulation in the region of integration in the PRP treated implant group, compared to untreated controls after 2 weeks (p<0.05). Immunohistochemical studies revealed that the integration zone was rich in collagen type II and aggrecan. The cells at the zone of integration in the PRP soaked group had a 2.5 fold increase in aggrecan gene expression (p=0.05) and a 3.5 fold increase in matrix metalloproteinase 13 expression (p<0.05) compared to controls.

Conclusion: PRP soaked bio-engineered cartilage implants showed improved integration with native cartilage compared to non-treated implants, perhaps due to the increased matrix accumulation and remodeling at the interface. Further evaluation is required to determine if PRP improves integration in vivo.

51 - Optimal Seeding Densities for in vitro Chondrogenesis of Two and Three Dimensional-isolated and Expanded Bone Marrow-derived Mesenchymal Stromal Stem Cells within a Porous Collagen Scaffold

Troy D Bornes, AB; Nadr M Jomha, AB; Aillette Mulet-Sierra, AB; Adetola B Adesida, AB

Purpose: 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. Therefore, tissue-engineering variables, such as cell expansion environment and seeding density of scaffolds, are currently under investigation. The objectives of this study were to demonstrate chondrogenic differentiation of BMSCs seeded within a collagen I scaffold following isolation and expansion in two-dimensional (2D) and three-dimensional (3D) environments, and assess the impact of seeding density on in vitro chondrogenesis. It was hypothesized that both expansion protocols would produce BMSCs capable of hyaline-like chondrogenesis with an optimal seeding density of 10 million cells/cm3.

Method: Ovine BMSCs were isolated in a 2D environment by plastic adherence, expanded to passage two in flasks containing expansion medium, and seeded within collagen I scaffolds (6 mm diameter, 3.5 mm thickness and 0.115 ± 0.020 mm pore size; Integra LifeSciences Corp.) at densities of 50, 10, 5, 1, and 0.5 million BMSCs/cm3. For 3D isolation and expansion, bone marrow aspirates containing known quantities of mononucleated cells (BMNCs) were seeded on scaffolds at 50, 10, 5, 1, and 0.5 million BMNCs/cm3 and cultured in expansion medium for an equivalent duration to 2D expansion. All cell-scaffold constructs were differentiated in vitro in chondrogenic medium containing transforming growth factor-beta three for 21 days and assessed with RT-qPCR, safranin O staining, histological scoring using the Bern Score, collagen immunofluorescence, and glycosaminoglycan (GAG) quantification.

Results: Two dimensional-expanded BMSCs seeded at all densities were capable of proteoglycan production and displayed increased expressions of aggrecan and collagen II mRNA relative to pre-differentiation controls. Collagen II deposition was apparent in scaffolds seeded at 0.5-10 million BMSCs/cm3. Chondrogenesis of 2D-expanded BMSCs was most pronounced in scaffolds seeded at 5-10
million BMSCs/cm³ based on aggrecan and collagen II mRNA, safranin O staining, Bern Score, total GAG, and GAG/DNA. For 3D-expanded BMSC-seeded scaffolds, increased aggrecan and collagen II mRNA expressions relative to controls were noted with all densities. Proteoglycan deposition was present in scaffolds seeded at 0.5-50 million BMNCs/cm³, while collagen II deposition occurred in scaffolds seeded at 10-50 million BMNCs/cm³. The highest levels of aggrecan and collagen II mRNA, Bern Score, total GAG, and GAG/DNA occurred with seeding at 50 million BMNCs/cm³.

**Conclusion:** Within a collagen I scaffold, 2D- and 3D-expanded BMSCs are capable of hyaline-like chondrogenesis with optimal cell seeding densities of 5-10 million BMSCs/cm³ and 50 million BMNCs/cm³, respectively. Accordingly, these densities could be considered when seeding collagen I scaffolds in BMSC transplantation protocols.

52 - Do Anatomical Parameters of Cam FAI Influence Hip Joint Mechanics during Level Walking?
**Mario Lamontagne, ON; Geoffrey Ng, ON; Danilo S. Catelli, ON; Paul E. Beaulé, ON**

**Purpose:** With the growing number of individuals with asymptomatic cam-type deformities, elevated alpha angles alone do not always explain clinical signs of femoroacetabular impingement (FAI). Differences in additional anatomical parameters may affect hip joint mechanics, altering the pathomechanical process resulting in symptomatic FAI. The purpose was to examine the association between anatomical hip joint parameters and kinematics and kinetics variables, during level walking.

**Method:** Fifty participants (m = 46, f = 4; age = 34 ± 7 years; BMI = 26 ± 4 kg/m²) underwent CT imaging and were diagnosed as either: symptomatic (15), if they showed a cam deformity and clinical signs; asymptomatic (19), if they showed a cam deformity, but no clinical signs; or control (16), if they showed no cam deformity and no clinical signs. Each participant’s CT data was measured for: axial and radial alpha angles, femoral head-neck offset, femoral neck-shaft angle, medial proximal femoral angle, femoral torsion, acetabular version, and centre-edge angle. Participants performed level walking trials, which were recorded using a ten-camera motion capture system (Vicon MX-13, Oxford, UK) and two force plates (Bertec FP4060-08, Columbus, OH, USA). Peak sagittal and frontal hip joint angles, range of motion, and moments were calculated using a custom programming script (MATLAB R2015b, Natick, MA, USA). A one-way, between groups ANOVA examined differences among kinematics and kinetics variables (α = 0.05), using statistics software (IBM SPSS v.23, Armonk, NY, USA); while a stepwise multiple regression analysis examined associations between anatomical parameters and kinematics and kinetics variables.

**Results:** No significant differences in kinematics were observed between groups. The symptomatic group demonstrated lower peak hip abduction moments (0.12 ± 0.08 Nm/kg) than the control group (0.22 ± 0.10 Nm/kg, p = 0.01). Sagittal hip range of motion showed a moderate, negative correlation with radial alpha angle (r = -0.33, p = 0.02), while peak hip abduction moment correlated with femoral neck-shaft angle (r = 0.36, p = 0.009) and negatively with femoral torsion (r = -0.36, p = 0.009). With peak hip abduction moment in the stepwise regression analysis, femoral torsion accounted for a variance of 13.3% (F(1, 48) = 7.38; p = 0.009), while together with femoral neck-shaft angle accounted for a total variance of 20.4% (R² change = 0.07, F(2, 47) = 6.01; p = 0.047).
**Conclusion:** Although elevated radial alpha angles may have limited sagittal range of motion, the cam deformity parameters did not affect joint moments. Femoral neck-shaft angle and femoral torsion were significantly associated with peak hip abduction moment, suggesting that the insertion location of the abductor affects muscle’s length and its resultant force vector. A varus neck angle, combined with severe femoral torsion, may ultimately influence muscle moment arms and hip mechanics in individuals with cam FAI.

**53 - The Effect of Radial Head Resection on Load Transfer in the Ulnohumeral Joint: An Experimental Biomechanical Study**

*Jennifer Ng, ON; Masao Nishiwaki, Japan; Braden Gammon, ON; George Athwal, ON; Graham King, ON; Jim Johnson, ON*

**Purpose:** Fracture or resection of the radial head can cause unbalance and long-term functional complications in the elbow. Studies have shown that a radial head excision can change elbow kinematics and decrease elbow stability. The radial head is also important in both valgus and varus laxity and displacement. However, the effect of radial head on ulnohumeral joint load is not known. The objective of this experimental study was to compare the axial loading produced at the ulnohumeral joint during active flexion with and without a radial head resection.

**Method:** Ten cadaveric arms were used. Each specimen was prepared and secured in an elbow motion simulator. To simulate active flexion, the tendons of the biceps, brachialis, brachioradialis, and triceps were attached to servo motors. The elbow was moved through a full range of flexion. To quantify loads at the ulnohumeral joint, a load cell was implanted in the proximal ulna. Testing was conducted in the intact then radial head resected case, in supination in the horizontal, vertical, varus and valgus positions.

**Results:** When comparing the average loads during flexion, the axial ulnar load in the horizontal position was 89±29N in an intact state compared to 122±46N during radial head resection. In the vertical position, the intact state produced a 67±16N load while the resected state was 78±23N. In the varus and valgus positions, intact state resulted in loads of 57±26N and 18±3N, respectively. Conversely, with a radial head resection, varus and valus positions measured 56±23N and 54±23N loads, respectively. For both joint configurations, statistical differences were observed for all flexion angles in all arm positions during active flexion (p=0.0001). When comparing arm positions and flexion angle, statistical differences were measured between valgus, horizontal and vertical (p<0.005) except for varus position (p=0.64).

**Conclusion:** Active flexion caused a variation in loads throughout flexion when comparing intact versus radial head resection. The most significant variation in ulnar loading occurred during valgus and horizontal flexion. The vertical and varus position showed little variation because the position of the arm is not affected by the loss of the radial head. However, in valgus position, the resected radial head creates a void in the joint space and, with gravity, causes greater compensatory ulnar loading. In the horizontal position, the forearm is not directly affected by gravitational pull and cannot adjust to counterbalance the resected radial head, therefore loads are localized in the ulnohumeral joint. These findings prove the importance of the radial head and that a radial head resection can overload the ulnohumeral side.
Carpal Kinematics During Simulated Wrist Motion
Helen L Stoesser, ON; Clare Padmore, ON; Masao Nishiwaki, Kawasaki; Braden Gammon, ON; G Daniel G Langohr, ON; Emily Lalone, ON; James A Johnson, ON; Graham JW King, ON

Purpose: Wrist motion is achieved primarily via rotation at the radiocarpal and midcarpal joints. The contribution of each carpal bone to total range of motion has been previously investigated, although there is no consensus regarding the influence of each structure to global wrist motion. The objective of this comprehensive in-vitro biomechanical study was to determine the kinematics of the capitate, scaphoid and lunate during unconstrained simulated wrist flexion-extension. In addition, this study examined the effect of motion direction (i.e. flexion or extension) on the kinematics and contribution of the carpal bones.

Method: Seven fresh frozen cadaveric upper limb specimens (age: 67±18 yrs) were amputated mid-humerus, and the wrist flexors/extensors were exposed and sutured at their musculotendinous junctions. Each specimen was mounted on a wrist motion simulator in neutral forearm rotation with the elbow at 90° flexion. Passive flexion and extension motion of the wrist was simulated by moving a K-wire, inserted into the third metacarpal, through the flexion/extension motion arc at a speed of ~5 mm/sec under muscle tone loads of 10N. Carpal kinematics were captured using optical tracking of bone fixated markers. Kinematic data was analyzed from ±35° flexion/extension.

Results: Scaphoid and lunate motion differed between wrist flexion and extension, but correlated linearly (R^2=0.99,0.97) with capitate motion. In wrist extension, the scaphoid (p=0.03) and lunate (p=0.01) extended 83±19% & 37±18% respectively relative to the capitate. In wrist flexion, the scaphoid (p=1.0) and lunate (p=0.01) flexed 95±20% and 70±12% respectively relative to the capitate. The ratio of carpal rotation to global wrist rotation decreased as the wrist moved from flexion to extension. The lunate rotates on average 46±25% less than the capitate and 35±31% less than the scaphoid during global wrist motion (p=0.01). The scaphoid rotates on average 11±19% less than the capitate during wrist flexion and extension (p=0.07). There was no difference in the contribution of carpal bone motion to global wrist motion during flexion (p=0.26) or extension (p=0.78).

Conclusion: The capitate, lunate and scaphoid move synergistically throughout planar motions of the wrist. Our study found that both the scaphoid and lunate contributed at a greater degree during wrist flexion compared to extension, suggesting that the radiocarpal joint plays a more critical role in wrist flexion. Our results agree with previous studies demonstrating that the scaphoid and lunate do not contribute equally to wrist motion and do not function as a single unit during planar wrist motion. The large magnitude of differential rotation observed between the scaphoid and lunate may be responsible for the high incidence of scapholunate ligament injuries relative to other intercarpal ligaments. An understanding of normal carpal kinematics may assist in developing more durable wrist arthroplasty designs.
55 - Orthogonal Plating of Vancouver B1 and C-type Periprosthetic Femur Fracture Nonunions

Christopher E Birch, US; Michael Blankstein, US; Craig S Bartlett III, US

**Purpose:** Periprosthetic femoral shaft fractures are a significant complication of total hip arthroplasty. Plate osteosynthesis with or without onlay strut allograft has been the mainstay of treatment around well-fixed stems. Nonunions are a rare, challenging complication of this fixation method. The number of published treatment strategies for periprosthetic femoral nonunions are limited. In this series, we report the outcomes of a novel orthogonal plating surgical technique for addressing nonunions in the setting of Vancouver B1 and C-type periprosthetic fractures that previously failed open reduction internal fixation (ORIF).

**Method:** A retrospective chart review of all patients from 2010 to 2014 with Vancouver B1/C total hip arthroplasty periprosthetic femoral nonunions was performed. All patients were treated primarily with ORIF. Nonunion was defined as no radiographic signs of fracture healing nine months post-operatively, with or without hardware failure. Exclusion criteria included open fractures and periprosthetic infections. The technique utilized a mechanobiologic strategy of atraumatic exposure, resection of necrotic tissue, bone grafting with adjuvant recombinant growth factor and revision open reduction internal fixation. Initially, compression was achieved using an articulated tensioning device and application of an anterior plate. This was followed by locked lateral plating. Patients remained non-weight bearing for eight weeks.

**Results:** Six Vancouver B1/C periprosthetic femoral nonunions were treated. Five patients were female with an average age of 80.3 years (range 72-91). The fractures occurred at a mean of 5.8 years (range 1-10) from their initial arthroplasty procedure. No patients underwent further revision surgery; there were no wound dehiscence, hardware failures, infections, or surgical complications. All patients had a minimum of nine months follow up (mean 16.6, range 9-36). All fractures achieved osseous union, defined as solid bridging callus over at least two cortices and pain free, independent ambulation, at an average of 24.4 weeks (range 6.1-39.7 weeks).

**Conclusion:** To our knowledge, this is the first case series describing 90-90 locked compression plating using modern implants for periprosthetic femoral nonunions. This is a rare but challenging complication of total hip arthroplasty and we present a novel solution with satisfactory preliminary outcomes. Orthogonal locked compression plating utilizing an articulated tensioning device and autograft with adjuvant osteoinductive allograft should be considered in periprosthetic femur fractures around a well-fixed stem. Further biomechanical and clinical research is needed to improve our treatment strategies in this population.

56 - Early Results of 500 Maxera® Monoblock Acetabular Component With A Large Ceramic Bearings at 2 Years Follow Up

Abdulaziz Almaawi, QC; Anthony Deny, France; Alain Roy, QC; Vincent Massé, QC; Martin Lavigne, QC; Pascal-André Vendittoli, QC
Purpose: Large bearing surfaces are appealing in total hip arthroplasty (THA) as they may help create a greater range of impingement free motion and reduce the risk of dislocation. However, attempts to achieve this with a metal bearing surface have been blighted by adverse reactions to metal debris. Ceramic bearings have a good long-term track record in more conventional head sizes, and manufacturing techniques now permit the use of larger ceramic bearing surfaces using monoblock uncemented acetabular components. In this study, we are reviewing the early results of the Maxera® acetabular component (Zimmer, Indiana) at our institution.

Method: All data was collected prospectively. Maxera® acetabular component is a Titanium (Ti) shell with plasma sprayed Ti for the osteointegrative surface. Delta ceramic liner is inserted & locked into the cup shell by the manufacturer (non-modular). With the Maxera cup system, the bearing diameter is dictated by the acetabular component size. Acetabular components (AC) of 46 and 48 mm have a bearing diameter (BD) of 36 mm, AC of 50 and 52 mm : have a 40 mm BD, AC of 54 and 56 mm : have a BD of 44 mm and AC of 58-64 : have a 48mm BD. Delta ceramic femoral head size of 44 and 48 mm have a modular Ti sleeve between the head and femoral stem trunnion. Femoral head sizes of 36 and 40 mm have no Ti sleeve. All THA had an uncemented femoral stem. Implants were inserted with a posterior approach. Patients were reviewed at 6 weeks, 6 months and then annually with radiographs. Clinical function was evaluated using WOMAC and UCLA scores along with joint perception questionnaires.

Results: Five hundred components have been implanted in 442 patients (250 women, 192 men) with a mean age of 55, (min 17, max 80) and a mean BMI of 26.9 (min 17.8, max 51). The mean acetabular size was 54 (min 46, max 64), leading to a mean femoral head size of 44. At a minimum of two years follow-up (mean 3.8 years): 5 patients have been revised, 4 secondary to undetected intraoperative fracture of the femur and only one due to early displacement of a Maxera® cup (0.2%). Five patients reported a mild squeaking; two reported clicking and one patient presented with a symptomatic heterotopic ossification. The WOMAC score improved significantly post-operatively, (57.4 compared to 4.4 post-operatively, p<0.001). The mean post-operative UCLA score was 6.9. Sixty percent (60.6%) of patients rated their joint perception as either “natural” or “artificial without limitation”. two patients (0.4%) suffered a dislocation after high velocity trauma without recurrence after closed reduction. No ceramic component fracture was recorded.

Conclusion: This prospective study shows that this monoblock acetabular component provides an easy implantation with minimal complications. The ceramic bearing surface provides good clinical function and joint perception. Bearing surfaces of this design may provide an alternative to large head metal on metal (MoM) implants without the side effects of metal debris/ions.

57 - Systemic Absorption of Intravenous and Topical Tranexamic Acid in Primary Total Hip Arthroplasty
Richard Nadeau, ON; James Howard, ON; Fiona Ralley, ON; Lyndsay Somerville, ON; Douglas Naudie, ON

Purpose: Tranexamic acid (TEA), an antifibrinolytic agent, is routinely used for reduction of blood loss in total hip arthroplasty (THA). However, use of intravenous (IV) TEA has been questioned due to safety concerns and a lack of biochemical data in the arthroplasty literature. Tranexamic acid given topically as a periarticular solution is a promising alternative route of administration. The purpose of this study is to
identify differences in systemic absorption for intravenous and topical TEA administered during primary THA.

**Method:** In a blinded randomized controlled trial of patients undergoing primary cementless total hip arthroplasty, 29 participants received a weight-based bolus infusion of intravenous TEA (20 mg/kg) 10 minutes prior to skin incision. Conversely, 15 participants received a 1.5 g bolus dose of TEA administered topically into the periarticular region of the operative hip at the time of arthrotomy closure. A blood sample was drawn one hour post-administration for measurement of serum TEA concentration (µg/mL) by tandem mass spectrometry. In addition to comparing mean concentration levels for both treatment arms, each sample concentration was referenced to a pre-determined TEA concentration threshold of 10 µg/mL, a value known to represent 80% tissue plasminogen activator (tPA) inhibition in vivo.

**Results:** Those participants receiving topical TEA had four-fold lower TEA levels at one hour postoperatively (mean 12.44 ± 17.59 versus 52.54 ± 23.94 µg/mL, p<0.05).

**Conclusion:** These results demonstrate significantly lower circulating TEA at one hour after topical administration. Intravenous TEA must travel through the intravascular compartment in order to reach the operative hip. Topical administration of TEA targets bleeding tissues within the surgical field without necessitating parenteral administration. This results in less inhibition of tPA away from the operative site, potentially decreasing the risk of developing a pro-thrombotic state postoperatively. Correlating these results with outcomes from clinical efficacy trials comparing intravenous and topical TEA use in THA will further clarify optimal dosing strategies.

**58 - Tribocorrosion: Ceramic versus Cobalt Chromium Metal Heads in Total Hip Arthroplasty**

**Brent Lanting, ON; Sok Cheun Tan, Singapore; Adrian Lau, Singapore; Matthew Teeter, ON; Christopher DelBalso, ON; Richard McCalden, ON; Steven MacDonald, ON; Edward Vasarhelyi, ON; James McAuley, ON; Douglas Naudie, ON; James Howard, ON**

**Purpose:** Trunnionosis in modular hip arthroplasty has recently been recognized to be clinically important. Gaining an understanding of how the material interface at the head-trunnion affects the tribology at the modular junctions has current clinical implications as well as an implication on future implant selection and material choice. This matched-cohort study aims to compare tribocorrosion between ceramic and cobalt-chromium trunnions and to investigate other factors that contribute to the difference in tribocorrosion if present.

**Method:** All hip prostheses retrieved between 1999 and 2015 at one center were reviewed. Fifty two ceramic heads were retrieved, and these were matched to a cobalt-chromium cohort according to taper design, head size, neck length and implantation time in that order. The two cohorts were similar in male:female ratio (p=0.32) and body mass index (p=0.15) though the ceramic group was younger than the cobalt-chromium group (56.6 (+/-)13.5 years for ceramic group vs 66.3 (+/-14.4) years for cobalt-chromium group; p=0.001). There was no significant difference in the reasons for revision between the two groups (p=0.42). The femoral head trunnions were examined by two independent observers using a
previously published 4-point scoring technique. The trunnions were divided into three zones: apex, middle and base. The observers were blinded to clinical and manufacturing data where possible.

**Results:** Ceramic head trunnions demonstrated a lower median fretting and corrosion score at the base zone (p<0.001), middle zone (p<0.001) and in the combined score (p<0.001). In a subgroup analysis by head size, ceramic heads had a lower fretting and corrosion score at 28mm head diameter (p<0.001). Within the ceramic group, taper design had a significant effect on fretting and corrosion in the apex zone (p=0.04). Taper design also had a similar effect in the cobalt-chromium group in the apex zone (p=0.03). For the ceramic trunnions, the largest effect was contributed by the difference between the 11/13 taper and the 12/14 taper. For the cobalt-chromium trunnions, the largest effect was contributed by the difference between the 5 degree 38° 37° taper and type 1 taper.

**Conclusion:** Ceramic head trunnions showed a significantly lower fretting and corrosion score as compared to cobalt-chromium trunnions. Ceramic heads had a lower score than cobalt-chromium heads at 28mm head diameter. Taper design had an effect on fretting and corrosion within each cohort.

59 - Is There a Role for Pre-operative Iron Supplementation in Patients Preparing for a Total Knee or Total Hip Arthroplasty?

**Sara Neely, ON; Donna Berta, ON; Fiona Ralley, ON; Brent Lanting, ON; Edward Vasarhelyi, ON; James McAuley, ON; Richard McCalden, ON; Steven MacDonald, ON; Douglas Naudie, ON; James Howard, ON**

**Purpose:** Total joint arthroplasty is commonly associated with post-operative anemia. Blood conservation programs have been developed to optimize patients prior to surgery. Epoetin Alfa (Eprex) or intravenous (IV) iron transfusions are two modalities that can be used pre-operatively to optimize hemoglobin and ferritin levels. There are, however, potential complications and increased costs associated with their use. Oral iron is a less costly option for those undergoing surgery but requires more time to take effect. There are no studies to date that examine the effects of an early screening program utilizing oral iron supplementation prior to total joint arthroplasty. The purpose of this study is to evaluate the effect of implementing early pre-operative oral iron supplementation on patients prior total joint arthroplasty.

**Method:** A retrospective review of patients undergoing total joint arthroplasty was performed using our institution clinical informatics database. We identified all patients seen in pre-admission clinic (PAC) between Jan 1, 2009 and March 31, 2010 representing our control group. We then identified all patients seen in PAC between October 1, 2012 and December 31, 2013. Patients in this cohort received screening blood work when booked for surgery, and oral iron supplementation was given to patients with hemoglobin of less than 135g/L or ferritin less than 100ug/L, thus representing our treatment group. Patients undergoing revision, uni-compartment knee arthroplasty and bilateral arthroplasties were excluded from the study. Pearson Chi-Square tests were used to calculate significance between groups with main outcomes including pre-admission hemoglobin, and pre-operative requirements for Eprex or IV iron.
Results: In our control group, we identified 354 patients (25.6%) with hemoglobin less than 130 g/L at time of pre-admission clinic. In our treatment group, this number dropped significantly to only 16.4% of patients (p<0.005).

Conclusion: Implementation of an early screening program using oral iron supplementation resulted in a decrease in the number of patients with hemoglobin lower than 130 g/L at the time of pre-admission clinic. There was also a significant decrease in the use of Eprex and IV iron pre-operatively in the patients in the early screening program. These results encourage the use of early oral iron supplementation for patients with hemoglobin less than 135 g/L or ferritin less than 100ug/L in order to optimize patients prior to total joint arthroplasty.

60 - Effect of Acetabular Position on Polyethylene Liner Wear using a Novel Radiostereometric Analysis Technique
Prateek Goyal, ON; Xunhua Yuan, ON; Matthew Teeter, ON; Richard McCalden, ON; Steven MacDonald, ON; Edward Vasarhelyi, ON; James McAuley, ON; Douglas Naudie, ON; Brent Lanting, ON; James Howard, ON

Purpose: Studies that have previously examined the relationship between inclination angle and polyethylene wear have shown increased wear of conventional polyethylene with high inclination angles. To date, there have been no long term in vivo studies examining the correlation between cup position and polyethylene wear with highly crosslinked polyethylene.

Method: An institutional arthroplasty database was used to identify patients who had metal-on-highly crosslinked polyethylene primary total hip arthroplasty (THA) using the same component design with a minimum follow up of 10 years ago. A modified RSA examination setup was utilized, recreating standard anteroposterior (AP) and cross-table lateral exams in a single biplane RSA acquisition. Three dimensional head penetration was measured using the center index method. The same radiographs were used to measure inclination angle and anteversion. Spearman correlation was used to show an association between the parameters of acetabular position and wear rate.

Results: A total of 43 hips were included for analysis in this study. Average follow-up was 12.3 ± 1.2 years. The average linear wear rate was calculated to be 0.066 ± 0.066 mm/year. Inclination angle was not correlated with polyethylene wear rate (p=0.82). Anteversion was also not correlated with polyethylene wear rate (p=0.11). There was no statistical difference between wear rates of hips within Lewinnek’s “safe zone” and those outside this “safe zone” (p=0.11). Males had a higher wear rate of 0.094 ± 0.089 mm/year compared to females with a wear rate of 0.046 ± 0.032 mm/year (p=0.045).

Conclusion: At long term follow up of greater than 10 years, highly cross linked polyethylene has very low wear rates. This excellent tribology is independent of acetabular position, but gender did impact wear rates. Due to the low wear rates, follow-up of even longer term is suggested to examine variables affecting wear.

61 - Optimization of Enhanced Rapid Recovery After Surgery (ERAS) for Total Joint Arthroplasty – A Canadian Community Hospital Perspective
**Purpose:** Enhanced Recovery After Surgery (ERAS) is a multimodal perioperative care pathway designed to achieve early recovery for patients undergoing major surgery. ERAS allows for the incorporation of evidence based practices and incorporated a comprehensive assessment of the patient’s journey through the surgical process from pre-operative screening through to post-operative care. The purpose of this study was to determine if optimization of ERAS protocol with pre-operative screening and incorporating patient-specific factors into their post operative care would improve length of stay (LOS) and readmission rates following total joint arthroplasty (TJA) in a Canadian community hospital setting.

**Method:** The study collected clinical, demographic data and the physical status perioperative using the American Society of Anaesthesiologists (ASA) classification on 508 patients who underwent TJA between January and August 2015 and compared similar data from the same time frame in the previous calendar year prior to implementation of the pathway. Cohorts were analyzed for length of stay (LOS), readmission rates, Pre-operative assessments (completed by anaesthesia, nursing and pharmacy), relevant labs, patient history (surgery, medical, social), and patient values were all considered when developing a specific patient plan for care post-operatively. A post-operative management tool was used to optimize pain control, post-operative nausea and vomiting, bowel management, diabetes blood glucose control, venous thromboembolism prophylaxis, as well as monitoring parameters specific to patient medical history (e.g. respiratory, cardiac). While in hospital, physiotherapy and nursing were consulted by the pharmacist to assess whether patient’s post op management needed to be altered to optimize mobilization and recovery in hospital. The average patient’s LOS and readmission rates in 30 days was analyzed to assess the change after implementation of the post-operative management tool based on patient specific factors.

**Results:** A total of 508 patients (mean age: 66 years), ASA classification was 3 or greater for 430 patients. The patients were assessed for LOS, readmission rates in 30 days. The mean LOS decreased from 3.6 to 3.3 days after optimization of the ERAS protocol (student t test p=0.021). The 30-day readmission rate decreased from 2.9% to 1.4 % post intervention (z test p=0.087) when compared to the same time period in the previous calendar year prior to protocol implementation. Overall, the cost savings to optimizing the ERAS protocol for the hospital is substantial; with approximately $238 saved per patient.

**Conclusion:** Pre-operative screening and incorporating patient-specific factors into an individualized care plan to optimize the ERAS protocol for TJA reduced mean length of stay without a concomitant increase in readmission rates with significant cost saving.

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**62 - Mid Term Revision Risk of Primary Modular Total Hip Replacement Stems Findings from the Canadian Joint Replacement Registry**

**Eric Bohm, MB; Michael Dunbar, NS; Bas Masri, BC; Emil Schemitsch, ON; James Waddell, ON; Katy Molodianovitch, ON; Hong Ji, ON; Greg Webster, ON**
**Purpose:** Modular total hip arthroplasty (MTHA) stems were introduced in order to provide increased intra-operative flexibility for restoring hip biomechanics, improving stability and potentially reducing revision risk. However, the additional interface at the neck-body junction provides another location for corrosion or mechanical failure of the stem. To delineate the mid term revision risk of MTHA stems, we examined data from the Canadian Joint Replacement Registry (CJRR) at the Canadian Institute for Health Information (CIHI).

**Method:** Kinectiv, Profemur and Rejuvenate modular stems were identified from CJRR records submitted between 2004 and 2014. Revision status was determined by examining the discharge abstract database (DAD) also housed by CIHI, which collects information on all revisions, regardless of whether the procedure was submitted to CJRR.

**Results:** A total of 2446 modular stems were identified with a mean follow up of 4.2 years (range 0 to 10). Their usage peaked in 2012 (the first year of mandatory CJRR form submission for BC, ON and MB), and dropped rapidly thereafter. A total of 155 (6.3%) were revised. This consisted of 5/301 Kinectiv (1.7%), 141/2050 ProFemur (6.9%), and 9/96 Rejuvenate (9.4%) stems. As a group, this falls below the National Institute for Clinical Excellence (NICE) guidelines of 95% survival at 10 years.

**Conclusion:** While MTHA stems were introduced to improve outcomes and reduce revision risk, our findings of a 6.3% revision risk at a mean follow up of 4.2 years does not appear to support this.

63 - *In vivo* Wear Performance of Highly Cross-linked Polyethylene Across Three Femoral Head Articulations

**Colin MacLean, ON; Edward Vasarhelyi, ON; Brent Lanting, ON; Douglas Naudie, ON; Lyndsay Somerville, ON; Richard McCalden, ON; James McAuley, ON; Steven MacDonald, ON; James Howard, ON; Xunhua Yuan, ON; Matthew Teeter, ON

**Purpose:** The advent of highly cross-linked polyethylene has resulted in improved wear rates and reduced osteolysis with at least intermediate follow-up when compared to conventional polyethylene. However, the role of alternative femoral head bearing materials in decreasing wear is less clear. The purpose of this study was to determine in-vivo polyethylene wear rates across ceramic, Oxinium, and cobalt chrome femoral head articulations.

**Method:** A review of our institutional database was performed to identify patients who underwent a total hip arthroplasty using either ceramic or oxidized zirconium (Oxinium) femoral head components on highly cross-linked polyethylene between 2008 and 2011. These patients were then matched on implant type, age, sex and BMI with patients who had a cobalt chrome bearing implant during the same time period. RSA analysis was performed using the center index method to measure femoral head penetration (polyethylene wear). Secondary quality of life outcomes were collected using WOMAC and HHS Scores. Paired analyses were performed to detect differences in wear rate (mm/year) between the cobalt chrome cohorts and their matched ceramic and Oxinium cohorts. Additional independent group comparisons were performed by analysis of variance with the control groups collapsed to determine wear rate differences between all three cohorts.
Results: A total of 68 patients underwent RSA analysis. Fifteen patients with a ceramic femoral head component and 14 patients with an Oxinium femoral head component along with the same number of matched patients with cobalt chrome femoral head component were included in the analysis. The time in vivo for the Oxinium (5.17 +/− 0.96 years), Oxinium matched cohort (5.13 +/− 0.72 years), ceramic (5.15 +/− 0.76 years) and ceramic matched cohort (5.36 +/− 0.63 years) were comparable. The demographics of all bearing surface cohorts were similar. The paired comparison between the Oxinium and cobalt chrome cohorts (0.33 vs. 0.29 mm/year, p=0.284) and ceramic vs cobalt chrome cohorts (0.26 vs. 0.20 mm/year, p=0.137) did not demonstrate a significant difference in wear rate. The independent groups analysis revealed a significantly higher wear rate of Oxinium (0.33 mm/year) compared to cobalt chrome (0.24 mm/year) (p = 0.038). There were no differences in HHS and WOMAC scores between the Oxinium and cobalt chrome cohorts (HHS: p = 0.71, WOMAC: p=0.08) or the ceramic and cobalt chrome cohorts (HHS: p=0.15, WOMAC: p=0.23).

Conclusion: This study presents evidence of a greater wear rate (mm/year) of the Oxinium femoral head component compared to a cobalt chrome femoral head component. This difference was not demonstrated in the ceramic femoral head component. Despite this difference, there were no clinical differences as measured by the HHS and WOMAC. Future research should focus on factors that may contribute to the higher wear rate seen in the Oxinium cohort.

64 - The Economic Impact of Periprosthetic Infection in Total Hip Arthroplasty
Jason Akindolire, ON; Jacquelyn Marsh, ON; James Howard, ON; Brent Lanting, ON; Lyndsay Somerville, ON; Edward Vasarhelyi, ON

Purpose: Total hip arthroplasty (THA) has become one of the most commonly performed elective procedures. Today, there are nearly 50 000 annual hospitalizations for hip replacement surgery in Canada. This number is projected to increase significantly with the aging population. Periprosthetic joint infection (PJI) is the 3rd leading cause of failure following THA and is reported to occur at an incidence of 1-3%. A two-stage re-vision THA is the current gold standard treatment and this has a tremendous economic impact on the healthcare system. The purpose of this study is to create an accurate cost estimate of two-stage revision THA and, in turn, evaluate the economic burden of PJI as it compares to primary THA in a Canadian healthcare context.

Method: We conducted a retrospective review of primary THA cases and two-stage revision THA for PJI at our institution. Patients were matched for age and BMI. We recorded all costs associated with each procedure, including: OR time, equipment, length of hospital stay, readmission rates, and any other inpatient resource use. Unit costs were obtained using administrative data from the case costing department at London Health Sciences Centre. Billing fees associated with the procedure were obtained from the Ontario Schedule of Benefits. Descriptive statistics were used to summarize the demographic characteristics of patients, hospital costs and resource use data. Patients with PJI were compared to the matched cohort of primary THA using the t-test (for continuous variables), and the chi-square test (for categorical variables).

Results: Twenty consecutive cases of revision THA were matched to 20 patients who underwent uncomplicated primary THA between 2006 and 2014. Periprosthetic infection was associated with a
significant increase in hospital stay (26.5 vs. 2.0; p<0.001), clinic visits (9.5 vs. 3.8; p<0.001), readmission rates (12 vs. 1; p<0.001) and overall cost ($39 953 vs. $7 460; p<0.001) in comparison to the primary arthroplasty cohort.

**Conclusion:** Two-stage revision for infected THA is a significant economic burden to the healthcare system. Our data suggests a 5-fold increase in healthcare cost when compared to primary THA. This may be an important consideration when distributing resources among Canadian tertiary care centres.

65 - Two Year Migration of Cemented Total Hip Implant Stems Measured with RSA
Matthew Teeter, ON; Douglas Naudie, ON; Richard McCalden, ON; Xunhua Yuan, ON; Steven MacDonald, ON

**Purpose:** The philosophy of cemented total hip arthroplasty (THA) femoral components has become polarized. At one extreme are polished, collarless, tapered devices that are expected to subside; at the other extreme are roughened, non-tapered implants with a collar designed not to subside. Radiostereometric analysis (RSA) allows the accurate measurement of implant movement and has been extensively used for measurement of the in vivo migration of implants. The degree of migration as measured by RSA during the first years after surgery has been shown to correlate with the long-term performance of cemented femoral implants. The purpose of this study was to review the two-year RSA results of two different designs of primary cemented THA stems.

**Method:** Data from two previous prospective RSA trials with two-year follow-up were pooled. The first group included 36 patients who received a Spectron (Smith & Nephew, Memphis, USA) cemented stem. The second group included 13 patients who received an Exeter (Stryker, Mahwah, USA) cemented stem, and 15 patients who received a CPCS (Smith & Nephew, Memphis, USA) cemented stem. All patients underwent RSA examinations shortly post-operation, at 6 weeks, 3 months, 6 months, 1 years, and 2 years. Migration and rotation of the femoral stems was measured at each time point relative to the post-operative exam, and compared between the two groups.

**Results:** There was no difference in age at surgery (Spectron 78 ± 6 years, Exeter/CPCS 77 ± 5 years, p = 0.43), BMI (Spectron and Exeter/CPCS 28 ± 5 kg/m2, p = 0.92), or percentage of male patients (Spectron 23% male, Exeter/CPCS 21% male) between the implant groups. Subsidence was significantly greater (p < 0.0001) at all time points from three months to two years for the Exeter and CPCS stems (0.94 ± 0.39 mm at two years) compared to the Spectron stem (0.05 ± 0.16 mm at two years). There was no significant difference between the stem types for medial-lateral translation (p = 0.07) or anterior-posterior translation (p = 0.49), or for anterior-posterior tilt (p = 0.15), internal-external rotation (p = 0.89), or varus-valgus rotation (p = 0.05).

**Conclusion:** Implant material, design, and surface finish are all factors in the long-term performance of cemented femoral hip implants. In this study, both femoral stem designs had a magnitude of subsidence that was within the limits of what is considered to be safe with respect to long-term performance. The continuous subsidence of the Exeter and CPCS stems is consistent with previous reports in the literature.
Paper Session: COA/CORS Spine

66 - Ca2+ Regulates the Content of Type II Collagen and Proteoglycan in Intervertebral Discs by Activating the Extracellular Calcium-sensing Receptor

Michael P Grant, QC; Rakan Bokhari, QC; Laura M Epure, QC; John Antoniou, QC; Fackson Mwale, QC

Purpose: Calcification of the intervertebral disc (IVD) has been correlated with degenerative disc disease (DDD), a common cause of low back pain. The appearance of calcium deposits has been shown to increase with age, and its occurrence has been associated with several other disorders such as hyperparathyroidism, chondrocalcinosis, and arthritis. Trauma, vertebral fusion and infection have also been shown to increase the incidence of IVD calcification. The role of IVD calcification in the development DDD is unknown. Our preliminary data suggest that ionic calcium content and expression of the extracellular calcium-sensing receptor (CaSR), a G protein-coupled receptor (GPCR) and regulator of calcium homeostasis, are increased in the degenerated discs. However, its role in DDD remains unclear.

Method: IVD Cells: Bovine and normal human IVD cells were incubated in PrimeGrowth culture medium (Wisent Bioproducts, Canada; Cat# 319-510-CL, -S1, and S2) and supplemented with various concentrations of calcium (1.0, 1.5, 2.5, 5.0 mM), a CaSR agonist [5 µM], or IL-1β [10 ng/ml] for 7 days. Accumulated matrix protein was quantitated for aggrecan and type II collagen (Col II) by Western blotting. Conditioned medium was also collected from cells treated for 24h and measured for the synthesis and release of total proteoglycan using the DMMB assay and Western blotting for Col II content. IVD Cultures: Caudal IVDs from tails of 20-24 month old steers were isolated with the PrimeGrowth Isolation kit (Wisent Bioproducts, Canada). IVDs were cultured for 4 weeks in PrimeGrowth culture medium supplemented with calcium (1.0, 2.5, or 5.0 mM), or a CaSR agonist [5 µM]. Cell viability was measured in NP and AF tissue using Live/Dead Imaging kit (ThermoFisher, Waltham, MA), to determine if Ca2+ effects cell viability and the expression of aggrecan and Col II was evaluated in the IVD tissue by Western blotting. Histological sections were prepared to determine total proteoglycan content, alkaline phosphatase expression and degree of mineralization by von Kossa staining.

Results: The accumulation of aggrecan and Col II decreased dose-dependently in IVD cells following supplementation with calcium or the CaSR agonist. Conditioned medium also demonstrated decreases in the synthesis and release of proteoglycan and collagen with increasing Ca2+ dose or direct activation of the CaSR with agonist. A similar phenomenon was observed for total proteoglycan and aggrecan and Col II in IVDs following calcium supplementation or the CaSR agonist. In addition to decreases in Col II and aggrecan, increases in alkaline phosphatase expression and mineralization was observed in IVDs cultured in elevated Ca2+ concentrations without affecting cell viability.

Conclusion: Our results suggest that changes in the local concentrations of calcium are not benign, and that activation of the CaSR may be a contributing factor in IVD degeneration. Determining ways to minimize Ca2+ infiltration into the disc may mitigate disc degeneration.

67 - Quantification of Vertebral Trabecular Bone Strain Via Feature Based Image Registration
**Hoi-Ki Tong, ON; Michael Hardisty, ON; Cari Whyne, ON**

**Purpose:** Strain is a robust indicator of bone failure initiation. Previous work has demonstrated the measurement of vertebral trabecular bone strain by Digital Volume Correlation (DVC) of μCT scan in both a loaded and an unloaded configuration. This project aims to improve previous strain measurement methods relying on image registration, improving resolution to resolve trabecula level strain and to improve accuracy by applying feature based registration algorithms to μCT images of vertebral trabecular bone to quantify strain. It is hypothesized that extracting reliable corresponding feature points from loaded and unloaded μCT scans can be used to produce higher resolution strain fields compared to DVC techniques.

**Method:** The feature based strain calculation algorithm has two steps: 1) a displacement field is calculated by finding corresponding feature points identified in both the loaded and unloaded μCT scans 2) strain fields are calculated from the displacement fields. Two methods of feature point extraction, Scale Invariant Feature Transform (SIFT) and Skeletonization, were applied to unloaded (fixed) and loaded (moving) μCT images of a rat tail vertebra. Spatially non-uniform displacement fields were generated by automatically matching corresponding feature points in the unloaded and loaded scans. The Thin Plate Spline method and a Moving Least Squares Meshless Method were both tested for calculating strain from the displacement fields. Verification of the algorithms was performed by testing against known artificial strain/displacement fields. A uniform and a linearly varying 2% compressive strain field were applied separately to an unloaded 2D sagittal μCT slice to simulate the moving image.

**Results:** SIFT was unable to reliably match identified feature points leading to large errors in displacement. Skeletonization generated a more accurate and precise displacement field. TPS was not tolerant to small displacement field errors, which resulted in inaccurate strain fields. The Meshless Methods proved much more resilient to displacement field errors. The combination of Skeletonization with the Meshless Method resulted in best performance with an accuracy of -405μstrain and a detection limit of 1210μstrain at a strain resolution of 221.5μm. The DVC algorithm verified using the same validation test yielded a similar detection limit (1190μstrain), but with a lower accuracy for the same test (2370μstrain) for a lower resolution strain field (770μm) (Hardisty, 2009).

**Conclusion:** The Skeletonization algorithm combined with the Meshless Method calculated strain at a higher resolution, but with a similar detection limit, to that of traditional DVC methods. Future improvements to this method include the implementation of subpixel feature point identification and adapting this method of strain measurement into a 3D domain. Ultimately, a hybrid DVC/feature registration algorithm may further improve the ability to measure trabecular bone strain using μCT based image registration.

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**68 - Development of a Whole Bovine Long-term Organ Culture System that Retains Vertebral Bone for Intervertebral Disc Repair and Biomechanical Studies Using PrimeGrowth Media**

**Michael P Grant, QC; Laura M Epure, QC; Omar Salem, QC; Motaz Alaqeel, QC; John Antoniou, QC; Fackson Mwale, QC**
**Purpose:** Testing potential therapeutics in the regeneration of the disc requires the use of model systems. Although several animal models have been developed to test intervertebral disc (IVD) regeneration, application becomes costly when used as a screening method. The bovine IVD organ culture system offers an inexpensive alternative, however, in the current paradigm, the bony vertebrae is removed to allow for nutrient diffusion to disc cells. This provides limitations on the conditions and strategies one can employ in investigating IVD regeneration and mechanisms in degenerative disc disease (i.e. complex loading). Although one method has been attempted to extend the survival of bovine vertebrae containing IVDs (vIVD) cell viability declined after two weeks in culture. Our goal was to develop and validate a long-term organ culture model with vertebral bone, which could be used subsequently for studying biological repair of disc degeneration and biomechanics.

**Method:** Preparation of vIVDs: Bovine IVDs from the tails of 22-28-month-old steers were prepared for organ culture by parallel cuts through the adjacent vertebral bodies at 1cm from the endplates using an IsoMet®1000 Buehler precision sectioning saw. vIVDs were split into two groups: IVDs treated with PrimeGrowth Media kit (developed by Intervertech and licensed to Wisent Bioproducts) and IVDs with DMEM. The PrimeGrowth group was incubated for 1h in PrimeGrowth Isolation Medium (Cat# 319-511-EL) and the DMEM group for 1h in DMEM. After isolation, IVDs were washed in PrimeGrowth Neutralization Medium (Cat# 319-512-CL) while the other IVDs were washed in DMEM. The discs isolated with PrimeGrowth and DMEM were cultured for up to 5 months in sterile vented 60 ml Leakbuster™ Specimen Containers in PrimeGrowth Culture Medium (Cat# 319-510-CL) and DMEM with no mechanical load applied. Live/Dead Assay: vIVDs cultured for 1 or 5 months were dissected and cell viability was assessed in different regions by confocal microscopy using Live/Dead® (Invitrogen) fluorescence assay. Glucose Diffusion: After one month of culture, vIVDs were incubated for 72h in diffusion medium containing PBS (1x), CaCl2 (1mM), MgCl2 (0.5mM), KCl2 (5mM), 0.1% BSA and 150µM 2-NDBG, a D-glucose fluorescent analogue. Discs were dissected and IVD tissues were incubated in guanidinium chloride extraction buffer. Extracts were measured for fluorescence.

**Results:** After 5 months in culture, vIVDs prepared with PrimeGrowth kit demonstrated approximately 95% cell viability in all regions of the disc. However, dramatic reductions (~90%) in vIVD viability were measured in DMEM group after 1 month. vIVD viability was related to the amount of 2-NDBG incorporated into the disc tissue.

**Conclusion:** We have developed a novel method for isolating IVDs with vertebral bone capable of long-term viability. This method may not only help in the discovery of novel therapeutics in disc regeneration, but could also advance our understanding on complex loading paradigms in disc degeneration.

**69 - 2-year Follow-up in Spine Clinical Research: An Adequate Benchmark?**

**Firoz Miyanji, BC; Christopher Reilly, BC; Sameer Desai, BC; Amer F Samdani, US; Suken A Shah, US; Jahangir K Asghar, US; Burt Yaszay, US; Harry L Shufflebarger, US; Randal R Betz, US; Peter O Newton, CA**

**Purpose:** Most long-term follow-up studies report retrospective data, the quality of which remains limited due to their inherent biases. Prospective databases may overcome these limitations, however, feasibility and costs limit their application. To date there exists a paucity of evidence-based literature on which recommendations can be made for the ideal length of follow-up for spinal deformity research.
Therefore, our aim was to evaluate the added value of follow-up of patients beyond 2 years following surgery for AIS.

**Method:** A database registry evaluating surgical outcomes for all consecutive AIS patients with post-op data-points of 6 months, 1 year, 2 year, and 5 year was analyzed. Surgeon-reported complications, SRS-22 scores, and radiographic data were evaluated. Complications requiring surgical or medical intervention were compared between patients in whom complications developed within 2 years to those in which newly developed complications occurred between >2-5 years.

**Results:** 536 patients were analyzed. SRS-22 scores significantly improved at 2 years post-op with no change at 5-year follow-up. Overall complication rate was 33.2% with majority occurring within 2 years (24.8%). The rate of complications occurring >2-5 years requiring intervention was significantly lower than those requiring intervention within 2 years of surgery (4.7% vs 9.7%, p=0.000), however was not negligible. The most common newly observed complication beyond 2 years was pain (1.9%), followed by surgical site infection (SSI) (1.3%) and implant issues (0.56%). There were no significant differences in the rates of crankshaft (p=0.48), implant issues (p=0.56), pseudarthrosis (p=0.19), and SSI (p=0.13) between the 2 time points.

**Conclusion:** Although majority of complications following AIS surgery occurs within 2 years, a non-negligible rate of newly observed complications occur at >2-5 years post-op. Specifically crankshaft, pseudarthrosis, implant issues, and SSI have similar rates of occurrence at these 2 time points.

**70 - Patients’ Triage and Prioritization in Orthopaedics: Expert Consensus and Systematic Review**

Marie Beausejour, QC; Astrid Brousselle, QC; Mylaine Breton, QC; Michael Eshiemokhai, QC; Neil Saran, QC; Hubert Labelle, QC; Stefan Parent, QC; Jean-Marc Mac-Thiong, QC; Jean A Ouellet, QC

**Purpose:** Referral patterns in spine clinic of young patients with suspected scoliosis is suboptimal with 19% of late referrals and 42% of inappropriate referrals. Patients’ triage and prioritization in spine clinic is a strategy to ensure that health care allocation is done according to the level of health needs, favoring effective management and efficient use of health care resources use. The objective of the study is to elaborate a model for triage and prioritization of young patients in spine clinic based on expert consensus and literature on best practices.

**Method:** This projects was structured in three parts: 1) We documented best evidence. We conducted a review of empirical studies evaluating triage and prioritization initiatives in order to identify key components for intervention success. 2) We elaborate a model of health care delivery with the professionals of a local paediatric spine clinic. In this model, the triage and prioritization algorithm was developed from list of potential factors (demographics, signs and perceived symptoms, provisional diagnoses and known co-morbidities, results of preliminary physical examination and radiological findings) that was submitted to five paediatric orthopaedic surgeons for rating according to their potential relevance to orient prioritization decisions. 3) We compared the professionals’ model of health care delivery to the literature synthesis in order to propose the best model.
Results: Seven key components of triage and prioritization systems were identified: centralized review of referral requests, list of consensual objectives criteria for triage, fast track evaluation of urgent cases, selection of cases for management at point of triage, cases prioritization to main consultant, multidisciplinary evaluation and alternatives pathways. The consensual decision algorithm confirmed that cases who should be seen in priority are immature patients presenting with a significant trunk deformity. In addition, presence of persisting neurological symptoms, severe incapacitating pain or night pain, as well as abnormal scan or MRI findings were considered as urgent/PI priority. Cases characteristics for evaluation by nurse practitioners as well as alternative pathways of management were defined. Acceptability, compatibility, clinical relevance and discriminant capacity of the new model of health care delivery were satisfactorily demonstrated.

Conclusion: Consensus was easily reached between the five respondents on factors supporting decisions to prioritize patients in spine clinic for suspected spinal deformity. Refinements to the initially proposed model according the identified key features from the literature, led to a final model of health care delivery that is evidence-base, feasible and coherent with the local context. Future implementation of this model should facilitate timely and appropriate health care delivery and best use of health care resources according to patients’ needs.

71 - Complications with and without the use of Computer-assistance in Lumbar Fusion Surgery: Analysis of 15,222 Patients in ACS-NSQIP Database
Ahmed Aoude, QC; Anas H Nooh, QC; Maryse Fortin, QC; Sultan Aldebayan, QC; Fahad H Abduljabbar, QC; Peter Jarzem, QC; Jean Ouellet, QC; Michael H Weber, QC

Purpose: The objective of this paper is to demonstrate the difference in post-operative complication rates between Computer-assisted surgery (CAS) and conventional techniques in spine surgery. Several studies have shown that the accuracy of pedicle screw placement significantly improves with use of CAS. Yet, few studies have compared the incidence of post-operative complications between CAS and conventional techniques.

Method: The American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database was used to identify patients that underwent posterior lumbar fusion from 2011 to 2013. Multivariate analysis was conducted to demonstrate the difference in post-operative complication rates between CAS and conventional techniques in spine surgery.

Results: Out of 15,222 patients, 14,382 (95.1%) were operated with conventional techniques and 740 (4.90%) were operated with CAS. Multivariate analysis showed that patients in the CAS group had less odds to experience adverse events post-operatively (OR 0.57, P <0.001).

Conclusion: This paper examined the complications in lumbar spinal surgery with or without the use of CAS. These results suggest that CAS may provide a safer technique for implant placement in lumbar fusion surgeries.

72 - Comparison of Adverse Event Recording Tools During a 10-week Prospective Pilot Study in Elective Spine Surgery Patients at a Tertiary Spine Centre
Katie Y P Garland, ON; Darren M Roffey, ON; Philippe Phan, ON; Eugene K Wai, ON; Stephen P Kingwell, ON

**Purpose:** Adverse events (AEs) following spine surgery are very common. It is important to monitor the incidence of AEs to ensure that appropriate practices are implemented to minimize AEs and improve patient outcomes. The Spine Adverse Events Severity System (SAVES) is a validated AE recording tool specifically designed for spine surgery and the Orthopaedic Surgical Adverse Events Severity System (OrthoSAVES) is a similar tool intended for general orthopaedic surgery. The main objective was to prospectively collect AE data from spine surgery patients using SAVES and OrthoSAVES and compare their viability and applicability for use. The longterm objective is to enhance patient safety by tracking AEs with a view towards potentially changing future healthcare practices to eliminate the risk factors for AEs.

**Method:** For a 10-week period in June-September 2015, three spine surgeons used SAVES to record AEs experienced by any elective spine surgery patients. In addition, a trained independent clinical reviewer with access to electronic records, medical charts, and allied health professionals (e.g. nurses, physiotherapists) used SAVES and OrthoSAVES to record AEs for the same patients. At discharge, the SAVES forms from the surgeons and SAVES and OrthoSAVES forms from the independent reviewer were collected and all AEs were recorded in a database.

**Results:** In 48 patients, the independent reviewer recorded a total of 45 AEs (4 intra-operative, 41 post-operative), compared to the surgeons who recorded a total of 8 AEs (2 intra-operative, 6 post-operative) (P2) were recorded by both the independent reviewer and surgeons. OrthoSAVES had the capacity to directly record 3 additional AEs that had to be included in the “Other” section on SAVES.

**Conclusion:** SAVES and OrthoSAVES are valuable tools for recording AEs. Use of SAVES and OrthoSAVES has the potential to enhance patient care and safety by ensuring AEs are followed by the surgeon during their in-hospital stay and prior to discharge. Independent reviewers are more effective at capturing AEs following spine surgery, and thus, could be recruited in order to capture more AEs and maximize different complication diagnoses in alignment with proposed diagnosis-based funding models. The next step is to analyze AE data identified by the hospital discharge abstract to determine whether retrospective administrative coding can adequately record AEs compared to prospectively-collected AE data with SAVES/OrthoSAVES.

**73 - Prevalence and Complications of Post-operative Transfusion for Cervical Fusion Procedures in Spine Surgery; An Analysis of 11,588 patients from the ACS-NSQIP Database**

Ahmed Aoude, QC; Sultan Aldebayan, QC; Maryse Fortin, QC; Anas H Nooh, QC; Peter Jarzem, QC; Jean Ouellet, QC; Michael H Weber, QC

**Purpose:** Cervical spine fusion have gained interest in the literature since these procedures are now ever more frequently being performed in an outpatient setting with few complications and acceptable results. The purpose of this study was to assess the rate of blood transfusion after cervical fusion surgery, and its effect, if any on complication rates.
Method: The American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database was used to identify patients that underwent cervical fusion surgery from 2010 to 2013. Univariate and multivariate regression analysis was used to determine post-operative complications associated with transfusion and cervical fusion.

Results: We identified 11,588 patients who had cervical spine fusion between 2010 and 2013. The overall rate of transfusion was found to be 1.47%. All transfused patients were found to have increased risk of: venous thromboembolism (TBE) (OR 3.19, CI: 1.16-8.77), myocardial infarction (MI) (OR 9.12, CI: 2.53-32.8), increased length of stay (LOS) (OR 28.03, CI: 14.28-55.01) and mortality (OR 4.14, CI: 1.44-11.93). Single level fusion had increased risk of: TBE (OR 3.37, CI: 1.01-11.33), MI (OR 10.5, CI: 1.88-59.89), and LOS (OR 14.79, CI: 8.2-26.67). Multilevel fusion had increased risk of: TBE (OR 5.64, CI: 1.15-27.6), surgical site infection (OR 16.29, CI: 3.34-79.49), MI (OR 10.84, CI: 2.01-58.55), LOS (OR 26.56, CI: 11.8-59.78) and mortality (OR 10.24, CI: 2.45-42.71). ACDF surgery had an increased risk of: TBE (OR 4.87, CI: 1.04-22.82), surgical site infection (OR 9.73, CI: 2.14-44.1), MI (OR 9.88, CI: 1.87-52.2), LOS (OR 28.34, CI: 13.79-58.21) and mortality (OR 6.3, CI: 1.76-22.48). Posterior fusion surgery had increased risk of: MI (OR 10.45, CI: 1.42-77.12) and LOS (OR 4.42, CI: 2.68-7.29).

Conclusion: Our results demonstrate that although cervical fusions can be done as outpatient procedures special precautions and investigations should be done for patients who receive transfusion after cervical fusion surgery. These patients are demonstrated to have higher rate of MI, DVT, wound infection and mortality when compared to those who do not receive transfusion.

74 - Do Lumbar Decompression and Fusion Patients Recall Their Preoperative Status? Recall Bias in Patient-reported Outcomes


Purpose: Although patient-reported outcomes (PROs) have become increasingly important in the evaluation of spine surgery patients, interpretability may be limited by a patient’s ability to recall pre-intervention impairment. The accuracy of patient recall of preoperative back pain, leg pain, and disability after spine surgery remains unknown. We sought to characterize the accuracy of patient recall of preoperative symptoms in a cohort of lumbar spine surgery patients.

Method: We analyzed consecutive patients undergoing lumbar decompression or decompression and fusion for lumbar radiculopathy by a single surgeon over a four-year period. Using standardized questionnaires, we recorded back and leg numeric pain scores (NPS) and Oswestry Disability Indices (ODI) preoperatively and asked patients to recall their preoperative status at a minimum of one-year following surgery. We then statistically compared and characterized patient recall of their pre-operative status and their actual pre-operative status. Patients with incomplete follow up or diagnoses other than degenerative lumbar stenosis were excluded.

Results: Sixty-seven patients with a mean age of 66.1 years (55% female) were included in the final analysis. All cases were either posterior or combined anterior/ posterior procedures. Mean levels of surgery was 1.7 and 93.8% of all cases were instrumented. Mean duration of preoperative symptoms
was 44.5 months (3.7 years). Preoperative vs postoperative PROs improved with regards to NPS back (5.2 vs 2.2, p= to 2 point difference), exceeding the minimal clinical important difference (MCID) for NPS. This pattern was maintained across age, gender, and duration of preoperative symptoms. We also observed cases of symptom minimization recall bias, and cases in which back and leg pain predominance were switched in severity during recall bias.

**Conclusion:** Significant recall bias of preoperative symptoms exists in patients undergoing spine surgery, potentially limiting accurate assessment and interpretation of PROs. An understanding of PROs and their limitations is essential to assess treatment efficacy of spinal procedures.

**75 - The Rate and Risk of Curve Progression following Skeletal Maturity— Does the Story End with Curve Magnitude?**

**Firoz Miyanji, BC;** Christopher Reilly, BC; Suken A Shah, DE; David H Clements, NJ; Amer F Samdani, PA; Sameer Desai, BC; Baron S Lonner, NY; Harry L Shufflerbarger, FL; Randal R Betz, NJ; Peter O Newton, CA

**Purpose:** Natural history of AIS >30° in skeletally mature patients is poorly defined. Studies reporting rates and risk factors for progression are predominantly of large curves in immature patients. Our aim was to determine the rate of curve progression in AIS following skeletal maturity, any associated changes in SRS-22 scores, and identify any potential predictors of curve progression.

**Method:** Patients enrolled in a prospective, longitudinal, multi-center non-surgical AIS database were evaluated. All patients had minimum 2 year follow-up, idiopathic scoliosis >30°, and were skeletally mature. SRS-22 functional outcome scores and radiographic data were compared at baseline and 2-year follow-up. Patients were divided into 3 groups based on curve size: A=30°-39°, B=40°-49°, C= >50°. Curve progression was defined as any change in curve magnitude.

**Results:** There were 80 patients, majority females (93.8%) with a mean age of 16.5+/-.16. Mean BMI was 21+/-.31 with 15.1% overweight. Mean major cobb at baseline was 38.3+/-.88°. At 2 year follow-up 46.3% of curves had progressed an average 3.4+/-.38°. Of curves that progressed, patients in group A had the largest mean rate of progression followed by group B. SRS-22 scores on average declined significantly over 2 years in this cohort (4.23 to 4.08; p=0.002). Patients who progressed had on average a more significant decline in SRS outcome scores compared to those that did not (p=0.018, p=0.041 respectively), with the most significant change noted in the Self-Image domain (p=0.03). There was no significant difference in the change in SRS scores over 2 years based on curve size. Univariate analysis did not identify any factors predictive of curve progression in this cohort.

**Conclusion:** Skeletally mature patients with AIS >30°may continue to have a risk of progression at a mean rate of 1.7°/yr and significant decline in SRS-22 outcome scores, in particular Pain and Self-Image, over time.

**76 - Incidence, Predictors and Post-operative Complications of Blood Transfusion in Thoracic and Lumbar Fusion Surgery: An Analysis of 14,249 patients from the ACS-NSQIP Database**

Ahmed Aoude, QC; Anas H Nooh, QC; Maryse Fortin, QC; Sultan Aldebyan, QC; Peter Jarzem, QC; Jean Ouellet, QC; Michael H Weber, QC
**Purpose:** Hemorrhage and transfusion requirements in spine surgery are common. This is especially true for thoracic and lumbar fusion surgeries. The purpose of this paper is to determine predictive factors for transfusion and their effect on short-term post-operative outcomes for thoracic and lumbar fusions.

**Method:** The American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database was used to identify patients that underwent lumbar or thoracic fusion surgery from 2010 to 2013. Univariate and multivariate regression analysis was used to determine predictive factors and post-operative complications associated with transfusion.

**Results:** A total of 14,249 patients were included in this study; 13,586 had lumbar fusion and 663 had thoracic fusion surgery. The prevalence of transfusion was 35% for thoracic fusion and 17.5% for lumbar fusion. The multivariate analysis showed that age between 50-60 (OR 1.38, CI: 1.23-1.54), age between 61-70 (OR 1.65, CI: 1.40-1.95), dyspnea (OR 1.11, CI: 1.02-1.23), hypertension (OR 1.14, CI: 1.02-1.27), ASA class (OR 1.73, 1.18-1.45), pre-operative blood transfusion (OR 1.91, CI: 1.04-3.49), and extended surgical time (OR 4.51, CI: 4.09-4.98) were predictors of blood transfusion requirements for lumbar fusion. While only pre-operative BUN (OR 1.04, CI: 1.01-1.06) and extended surgical time (OR 4.70, CI: 3.12-6.96) were predictors of transfusion for thoracic fusion. In contrast, higher pre-operative hematocrit was protective against transfusion. Patients transfused who underwent lumbar fusion had an increased risk to develop superficial wound infection, deep wound infection, venous thromboembolism, myocardial infarction and had longer length of hospital stay. Patients transfused who underwent thoracic fusion were more likely to have venous thromboembolism and extended length of hospital stay. However, mortality was not associated with blood transfusion.

**Conclusion:** This study used a large database to characterize the incidence, predictors and post-operative complications associated with blood transfusion in thoracic and lumbar fusion surgeries. Pre- and post-operative planning for patients deemed to be at high-risk of requiring blood transfusion should be considered to reduce post-operative complication in this population.
Paper Session: COA Upper Extremity 1

77 - Using the Modified Delphi Method to Establish Clinical Consensus for the Diagnosis and Treatment of Patients with Rotator Cuff Pathology
Aaron Bois, AB; Breda H Eubank, AB; Nicholas G Mohtadi, AB; Mark R Lafave, AB; J. Preston Wiley, AB; David M Sheps, AB

Purpose: Clinical pathways are optimal patient care processes that have been developed to improve the quality of care for patients. Anecdotal evidence has suggested that patients presenting to the healthcare system with rotator cuff tears experience less than ideal quality care plagued by lengthy wait times, challenges in coordinating care, and inefficient use of healthcare resources. Therefore, diagnosis and treatment of patients with rotator cuff tears are in need of quality improvement through evidence-informed decision making. The purpose of this study is to develop a clinical pathway for patients presenting to the healthcare system with rotator cuff tears.

Method: The following steps were taken in developing the clinical pathway: 1) a multidisciplinary expert panel was formed; 2) goals of the clinical pathway were identified by the panel; 3) the literature and current clinical practices for best practice were reviewed; 4) recommendations for treatment algorithms were developed using consensus methods.

Results: The panel consisted of fourteen experts representing the two largest cities in Alberta, Canada (Edmonton and Calgary). The team consisted of at least one member from the clinical domains of sport medicine, orthopaedic surgery, athletic therapy, and physiotherapy. The first goal of the clinical pathway was to standardize screening, diagnosis, and physical examination of the patient. The second goal was to provide recommendations for appropriate investigations. The final goal was to map steps in the patients’ care pathway including sequencing and timing recommendations for treatment and interventions. Best practices were reviewed by the panel and using a modified Delphi method, clinical pathways for three types of rotator cuff tears (acute, chronic, and acute-on-chronic) were developed.

Conclusion: A clinical pathway that reflected best practices was developed from the literature and experts. The clinical pathway for diagnosis and treatment of patients with rotator cuff pathology will help to standardized patient care, improve patient flow, reduce unnecessary interventions, reduce healthcare utilization and costs, and improve the quality of patient care.

78 - Immobilization in External Rotation After Primary Shoulder Dislocation Reduces the Risk of Recurrence in Young Patients: A Randomized Controlled Trial
Jean-Christophe Murray, QC; Alexandre Leclerc, QC; Stéphane Pelet, QC

Purpose: The traditional treatment for a primary anterior shoulder dislocation has been immobilization in a sling with the arm in adduction and internal rotation. The recurrence rates after the initial traumatic event range from 20% to 94%. However, recent results have suggested that recurrent instability after primary shoulder dislocation may be reduced with immobilization in external rotation. Since then, controversy exists regarding the position of immobilization following these injuries. The objective of the
present study was to compare immobilization in internal and external rotation after a primary anterior shoulder dislocation.

**Method:** Fifty patients presenting to our fracture clinic with a primary traumatic anterior dislocation of the shoulder were randomly assigned to treatment with immobilization in either internal rotation (IR; 25 patients) or external rotation (ER; 25 patients) for three weeks. In addition of a two-years clinical follow-up, patients underwent a magnetic resonance imaging (MRI) of the shoulder with intra-articular contrast within four days following the traumatic event, and then at three months of follow-up. The primary outcome was a recurrent dislocation within 24 months of follow-up. The secondary outcome was the healing rate of the labral lesion seen on MRI (if present) within each immobilization group.

**Results:** The follow-up rate after two years was 92% (23 of 25) in the IR group and 96% (24 of 25) in the ER group. The recurrence rate in the IR group (11 of 23; 47.8%) was higher than that in the ER group (7 of 24; 29.2%) but the difference did not reach statistical significance (p=0.188). However, in the subgroup of patients aged 20-40 years, the recurrence rate was significantly lower in the ER group (3 of 17; 6.4%) than that in the IR group (9 of 18; 50%, p<0.01). In the subgroup of patients with a labral lesion present on the initial MRI, the healing rate of the lesion was 46.2% (6 of 13) in the IR group and 60% (6 of 10) in the ER group (p=0.680). Overall, the recurrence rate among those who showed healing of the labrum (regardless of the immobilization group) was 8.3% (1 of 12), but patients who did not healed their labrum had a recurrence rate of 45.5% (5 of 11; p=0.069).

**Conclusion:** This study suggests that immobilization in ER reduces the risk of recurrence after a primary anterior shoulder dislocation in patients aged between 20 and 40 years. At two years follow-up, the recurrence rate is lower in patients who demonstrated a healed labrum at three months, regardless of the position of immobilization. Future studies are required in order to identify factors that can improve healing of the damaged labrum following a traumatic dislocation of the shoulder.

79 - Cost-effectiveness of Single Row versus Double Row Constructs in Arthroscopic Rotator Cuff Repair

**Adrian L Huang, ON; Kednapa Thavorn, ON; Sasha van Katwyk, ON; Peter Lapner, ON**

**Purpose:** The optimal approach to arthroscopic repair of the rotator cuff is controversial, and both single row and double row fixation methods are commonly used. Which construct yields the highest efficacy is not clear. Given the current era of increasing costs in which health care delivery models are aiming for improved efficiencies and optimal outcomes, a cost-effectiveness study was performed to inform the decision making process of the utilization of single versus double row repair. The purpose of this study was to evaluate the cost-effectiveness of single row versus double row constructs in patients undergoing arthroscopic rotator cuff repair

**Method:** A cost-utility analysis was performed. Health resource use and outcome data were obtained from a previous prospective randomized controlled trial in which 90 patients were randomized to two treatment arms, single row rotator cuff repair (n=48) and double row (n=42). The patients were followed over a two-year span from the time of initial surgery. Unit cost data were captured using case costs collected from the hospital database and the Ontario Schedule of Benefits. Utility values were
derived from published literature. The incremental cost effectiveness ratio (ICER), defined as the difference in cost between the two types of rotator cuff fixation divided by the difference in quality adjusted life years (QALY), was determined.

**Results:** Double row fixation was more costly ($2,279.94 versus $1,587.37) but was more effective than the single row method (QALY of 4.073 versus 4.055). An incremental cost-effectiveness ratio was estimated to be $38,504.92 per QALY for double row fixation relative to single row. This is well below the commonly used willingness to pay threshold of $50,000/QALY. Subgroup analysis demonstrated that patients with larger rotator cuff tears (>3cm) had a lower ICER, suggesting that double-row fixation may be more cost-effective in more severe tears.

**Conclusion:** Double row rotator cuff fixation is a cost-effective option compared to single row rotator cuff repair with an ICER of $38,504.92/QALY, well within the accepted willingness to pay threshold of $50,000/QALY. Furthermore, the ICER between single and double row fixation improved with larger rotator cuff tears (>3cm), suggesting an additional benefit of a double row construct in those cases.

**80 - Biologic Characterization of Rotator Cuff Tissue Repair: Do Mechanical Strain and Vitamin C Make a Difference?**

**Kyla Huebner, ON; David B O’Gorman, ON; Kenneth J Faber, ON**

**Purpose:** Rotator cuff repair is performed to treat shoulder pain and disability. Failure of the tendon repair site is common; one strategy to improve healing is to enforce a period of post-operative immobilization. Immobilization may have unintended effects on tendon healing. Tenocytes under uniaxial strain form more organized collagen and up regulate expression of proliferative genes. Vitamin C (ascorbic acid), an anti-oxidant that is a co-factor for collagen synthesis, has also been reported to enhance collagen deposition and organization. The purpose of this study was to compare human tenocyte cultures exposed to uniaxial cyclical strain with or without slow-release ascorbic acid (ascorbyl-2 phosphate) to determine their individual and combined effects on tissue remodelling and expression of tissue repair genes.

**Method:** Rotator cuff tissues were collected from degenerative supraspinatus tears from eight patients. Tenocytes were incorporated into 3D type I collagen culture matrices. Cultures were divided into four groups: 1) ascorbic acid (0.6mMol/L) + strain (1%-20% uniaxial cyclic strain at 0.1 Hz), 2) ascorbic acid unstrained, 3) strain + vehicle 4) unstrained + vehicle. Samples were fixed in paraffin, stained with picrosirius red and analyzed with circular polarizing light. A second set of cultures were divided into three groups: 1) 0.5mM ascorbic acid, 2) 1mM ascorbic acid, 3) vehicle cultured for 24, 72, 120 and 168 hours. Cell-free collagen matrix was used as a control. Tenocyte proliferation was assessed using the water soluble tetrazolium-1 (WST1) assay and f tissue repair gene expression (TGFB1, COL1A1, FN1, COLIII, IGF2, MMP1, and MMP13), were analyzed by qPCR. The data were analyzed using a Split model ANOVA with contrast and bonferroni correction and a one-way ANOVAs and Tukey’s test (p<0.05 was significant).

**Results:** Our results indicated that unstrained cultures with or without exposure to slow release ascorbic acid exhibited greater picrosirius red birifringency and an increase in collagen fiber deposition in a
longitudinal orientation compared to strained tenocytes. We found that slow release ascorbic acid promoted significant dose and culture-time dependent increases in tenocyte proliferation (p<0.05) but no obvious enhancement in collagen deposition was evident over cultures without ascorbic acid supplementation.

Conclusion: Based on these data, applying strain to tenocytes may result in less organized formation of collagen fibers, suggestive of fibrotic tissue, rather than tendon remodelling. This may indicate that a short period of immobilization post-rotator cuff repair is beneficial for the healing of tendons. Exposure to slow release ascorbic acid enhanced tenocyte proliferation, suggesting that supplementation with Vitamin C may improve tendon repair post-injury or repair. Future studies will assess levels of tissue repair-associated proteins as well as comparing traumatic and degenerative rotator cuff tears to healthy uninjured rotator cuff tissue.

81 - Challenging the Gold Standard: Shoulder Arthroscopy Does Not Adequately Visualize Pathology of the Long Head of Biceps Tendon
Adnan Saithna, England; Alison Longo, MB; Jeff Leiter, MB; Peter MacDonald, MB; Jason Old, MB

Purpose: The majority of studies reporting sensitivity and specificity data for imaging modalities and physical examination tests for long head of biceps (LHB) tendon pathology use arthroscopy as the gold standard. However, there is little published data to validate this as an appropriate benchmark. The aim of this study was to determine the maximum length of the LHB tendon that can be seen at glenohumeral arthroscopy and whether it allows adequate visualization of common sites of pathology.

Method: Seven female cadaveric specimens were studied. Mean age was 74 years (range 44-96 years). Each specimen underwent arthroscopy in lateral decubitus (LD) and beach chair (BC) positions. The LHB-tendon was tagged with a suture placed with a spinal needle marking the intra-articular length and the maximum excursions achieved using a hook and a grasper in both LD and BC positions. T-tests were used to compare data.

Results: The mean intra-articular and extra-articular lengths of the tendon were 23.9 mm and 82.3 mm respectively. The mean length of tendon that could be visualized by pulling it into the joint with a hook was significantly less than with a grasper (LD: hook 29.9 mm, grasper 33.9 mm, mean difference 4 mm, p=0.0032. BC: hook 32.7 mm, grasper 37.6 mm, mean difference 4.9 mm, p=0.0001). Using the BC position allowed visualization of a significantly greater length than the LD position when using either a hook (mean difference 2.86 mm, p=0.0327) or a grasper (mean difference 3.7 mm, p=0.0077). The mean length of the extra-articular part of the tendon visualized using a hook was 6 mm in LD and 8.9 mm in BC. The maximum length of the extra-articular portion visualized using this technique was 14 mm (17%).

Conclusion: Pulling the tendon into the joint with a hook does not allow adequate visualization of common distal sites of pathology in either LD or BC. Although the BC position allows a significantly greater proportion of the tendon to be visualized this represents a numerically small value and is not likely to be clinically significant. The use of a grasper also allowed greater excursion but results in iatrogenic tendon injury which precludes its use. The reported incidence of pathology in Denard zone C (distal to subscapularis) is 80% and in our study it was not possible to evaluate this zone even by using a
grasper or maximum manual force to increase excursion. This is consistent with the extremely high rate of missed diagnoses reported in the literature. Surgeons should be aware that the technique of pulling the LHB-tendon into the joint is inadequate for visualizing distal pathology and results in a high rate of missed diagnoses. Furthermore, efforts to achieve greater excursion by "optimum" limb positioning intra-operatively do not confer an important clinical advantage and are probably unnecessary.

82 - A Randomized Controlled Trial Comparing Arthrographic Joint Injection with and without Steroids for the Treatment of Adhesive Capsulitis
Allison Tucker, ON; Ryan Bicknell, ON; Christina Hiscox, AB

**Purpose:** Estimated to affect 2-5% of the population, adhesive capsulitis is a common cause of shoulder pain and dysfunction. The objective of this study is to determine if arthrographic injection of the shoulder joint with steroid, local anesthetic and contrast is an effective treatment modality for adhesive capsulitis and whether it is superior to arthrographic injection with local anesthetic and contrast alone.

**Method:** This is a double-blinded RCT of patients with a diagnosis of adhesive capsulitis who were randomly assigned to receive an image guided arthrographic glenohumeral injection with either triamcinalone (steroid), lidocaine (local anesthetic) and contrast or lidocaine and contrast alone. Outcome measures included active and passive shoulder range of motion (ROM) and functional outcomes assessed using the Shoulder Pain and Disability Index (SPADI), the Constant Score and a Visual Analog Scale for pain. Post-operative evaluation occurred at 3 weeks, 6 weeks and 12 weeks. Descriptive statistics were utilized to summarize patient demographics and other study parameters. One-way ANOVAs compared the VAS, Constant and SPADI scores across the different time points for both study groups. The post hoc Bonferroni correction was used to adjust for multiple comparisons.

**Results:** There were 37 shoulders injected with follow-up visits at 12 weeks. Twenty shoulders were randomized to receive local plus steroid and 17 shoulders received local anesthetic only. There were 21 females and 14 males with an average age of 54 years (range, 42-70). VAS scores for both patient groups were significantly improved (p<0.05) at all follow-up times. Goniometric testing demonstrated significant improvements in forward flexion and internal rotation at 90 degrees in the local group and only abduction in the local plus steroid group. There were no significant changes in the Constant scores for the local group (p=0.08), however, the Constant scores showed significant improvement for the local plus steroid group (p=0.003) at all follow-up time points. The local group showed significant improvement in their SPADI pain scores at the 12 week follow-up only (p=0.01). There were no significant differences in their SPADI disability scores (p=0.09). The local plus steroid group had significant improvement in SPADI pain and disability scores at all follow-up time points (p=0.001).

**Conclusion:** The optimal treatment for adhesive capsulitis remains unclear. Our study demonstrated that patients receiving an arthrographic injection of either steroid and local anesthetic or local anesthetic alone had significantly improved post-injection pain scores. However, only the steroid and local anesthetic group demonstrated improved SPADI disability and Constant scores. Thus, we believe that either treatment may be a good option for patients with adhesive capsulitis and can reliably relieve pain, but we would recommend the steroid with local anesthetic over the local anesthetic alone as it may provide improved function.
83 - Strength, Endurance and Clinical Outcomes of Chronic Distal Biceps Rupture Reconstruction with Tendon Graft

Thomas J. Goetz, BC; Brett KJ Kilb, BC; Mami Okada, BC

Comments: This is largest collection of outcomes of distal biceps reconstruction in the literature. 8 subjects prospectively measured pre and post reconstruction Strength deficit in patients with chronic tendon deficit is described

Purpose: To describe outcomes for 53 chronic distal biceps reconstructions with tendon graft. Clinical outcomes as well as strength and endurance in supination and flexion are reported. To examine eight patients measured pre- and post-reconstruction. To identify deficit in supination and flexion in chronic reconstruction

Method: 53 reconstructions of chronic distal biceps with tendon graft were carried out between 1999 and 2015. 26 subjects agreed to undergo strength testing after minimum one year follow up. Eight subjects were tested both before and after reconstruction. Primary outcomes were strength in elbow flexion and forearm supination. Strength testing of supination and flexion included maximum isokinetic power and endurance performed on a Biodex. Clinical outcomes measures included pre-operative retraction severity, surgical fixation technique, postoperative contour, range of motion, subjective satisfaction, SF-12, DASH, MAYO elbow score, ASES and pain VAS Non-parametric data was reported as median (interquartile range), while normally-distributed data was reported as mean with 95% Confidence Limits. Hypothesis testing was performed according to two-tailed, paired t-tests.

Results: Median time from index rupture to reconstructions 9.5 (range 3-108) months. Strength measurements were completed at a median follow-up time of 29 (range 12-137) months on 26 subjects. The proportion of patients that achieved 90% strength of the contralateral limb post-reconstruction was 65% (17/26) for peak supination torque, and 62% (16/26) for peak flexion torque. Supination and flexion endurance was 90% of the contralateral arm in 81% (21/26) and 65% (17/26) of subjects, respectively. Ten subjects (39%) achieved 90% strength of the contralateral arm on at least four of five strength tests. Eight of the 26 patients were evaluated pre- and post-surgery. As compared to the contralateral limb, chronic distal biceps rupture was found to have a mean [95%CI] deficit in peak supination torque of 31.0 [21.0, 42.9]% (p=0.002). Mean deficit in peak flexion torque of 34.2 [23.1, 45.4]% (p <0.001). Reconstruction resulted in an increase in peak supination torque of 33.5 [8.7, 58.3]% (p=0.0162), increase in peak flexion torque of 35.0 [6.4, 63.6]% (p=0.023), increase in isometric strength of 57.6 [36.1, 79.1]% (p<0.001), increase in supination endurance of 0.6 [-22.2, 23.4]% (p=0.668), and a decrease in flexion endurance of 4.8 [-23.3, 13.7](p=0.478). Ninety-six percent of the patients (25/26) were satisfied, or very satisfied with the overall outcome of the surgery, while median Mayo score post-reconstruction was 100 (range: 55-100).

Conclusion: Chronic distal biceps tendon rupture results in less supination loss and greater flexion loss than previously reported. Reconstruction with tendon graft results in a significant, but incomplete recovery of peak supination and flexion torque, but no significant change in endurance. Clinical patient satisfaction with surgical outcomes is high.
84 - Biceps Tenoscopy: A Novel Strategy for Reducing the Rate of Missed Pathology of the Long Head of Biceps Tendon
Adnan Saithna, England; Alison Longo, MB; Jeff Leiter, MB; Peter MacDonald, MB; Jason Old, MB

Purpose: Recent literature has demonstrated that conventional arthroscopic techniques do not adequately visualize areas of predilection of pathology of the long head of biceps (LHB) tendon and are associated with a 30-50% rate of missed diagnoses. The aim of this study was to evaluate the safety, effectiveness and ease of performing biceps tenoscopy as a novel strategy for reducing the rate of missed diagnoses.

Method: Five forequarter amputation cadaver specimens were studied. The pressure in the anterior compartment was measured before and after surgical evaluation. Diagnostic glenohumeral arthroscopy was performed and the biceps tendon was tagged to mark the maximum length visualized by pulling the tendon into the joint. Biceps tenoscopy was performed using 3 different techniques (1. Flexible video-endoscopy, 2. Standard arthroscopy via Neviaser portal. 3. Standard arthroscope via antero-superior portal with retrograde instrumentation). Each was assessed for safety, ease of the procedure and whether the full length of the extra-articular part of the LHB tendon could be visualized. The t-test was used to compare the length of the LHB tendon visualized at standard glenohumeral arthroscopy vs that visualized at biceps tenoscopy. An open dissection was performed after the arthroscopic procedures to evaluate for an iatrogenic injury to local structures.

Results: Biceps tenoscopy allowed visualization to the musculotendinous junction in all cases. The mean length of the tendon visualized was therefore significantly greater at biceps tenoscopy (104 mm) than at standard glenohumeral arthroscopy (33 mm) (mean difference 71 mm, p<0.0001). Biceps tenoscopy was safe with regards to compartment syndrome and there was no difference between pre- and postoperative pressure measurements (mean difference 0 mmHg, p=1). No iatrogenic injuries were identified at open dissection.

Conclusion: Biceps tenoscopy allows excellent visualization of the entire length of the LHB tendon and therefore has the potential to reduce the rate of missed diagnoses. This study did not demonstrate any risk of iatrogenic injury to important local structures or any risk of compartment syndrome. Clinical evaluation is required to further validate this technique.

85 - Teres Minor Hypertrophy is a Common and Negative Predictor in Outcomes after Rotator Cuff Repair

Purpose: Studies have shown that the trees minor plays an important role after total (TSA) and reverse (RSA) shoulder arthroplasty, as well as in maintenance of function in the setting of infraspinatus wasting. In this regard, teres minor hypertrophy has been described as a compensatory change in response to this infraspinatus wasting, and has been suggested that this compensatory hypertrophy may mitigate the loss of infraspinatus function in the patient with a large rotator cuff tear. The purpose of this study
was to determine the prevalence of teres minor hypertrophy in a cohort of patients undergoing rotator cuff repair, and to determine its prognostic effect, if any, on outcomes after surgical repair.

**Method:** Over a 3 year period, all rotator cuff repairs performed in a single practice by 3 ASES member surgeons were collected. Inclusion criteria included both preoperative and postoperative validated outcomes measures (minimum 2 year), and preoperative Magnetic Resonance Imaging (MRI) scanning. 144 patients met all criteria. MRIs were evaluated for rotator cuff tear tendon involvement, tear size, and Goutallier changes of each muscle. In addition, occupational ratios were determined for the supraspinatus, infraspinatus, and teres minor muscles. Patients were divided into 2 groups, based upon whether they had teres minor hypertrophy or not, based on a previously established definition. A 2 way ANOVA was used to determine the effect of teres minor hypertrophy (tear size by hypertrophy) and Goutallier changes (tear size by fatty infiltration) on the ASES change scores (α=0.05).

**Results:** Teres minor hypertrophy was a relatively common finding in this cohort of rotator cuff patients, with 51% of all shoulders demonstrating hypertrophy. Interestingly, in patients without an infraspinatus tear, teres minor hypertrophy was still present in 19/40 (48%) of patients. Teres minor hypertrophy had a significant, negative effect ASES scores after rotator cuff repair in patients with and without infraspinatus tearing, infraspinatus atrophy, and fatty infiltrative changes (P<0.05). In general, the presence of teres minor hypertrophy showed 10-15% less improvement (Figure 1) than when no hypertrophy was present, and this was consistent across all tear sizes, independent of Goutallier changes.

**Conclusion:** Teres minor hypertrophy is a common finding in the setting of rotator cuff tearing, including in the absence of infraspinatus tearing. Contrary to previous publications, the presence of teres minor hypertrophy in patients with rotator cuff repair does not appear to be protective as a compensatory mechanism. While further study is necessary to determine the mechanism or implication of teres minor hypertrophy in setting of rotator cuff repair, our results show it is not a positive of outcomes following rotator cuff repair.

86 - What Happens to Patients When We Don’t Repair Their Cuff Tears? Five-year Rotator Cuff Quality of Life Index (RC-QOL) Outcomes Following Non-operative Treatment of Patients with Full Thickness Rotator Cuff Tears

**Purpose:** The purpose of this study was to examine five-year outcomes of patients previously enrolled in a non-operative rotator cuff study.

**Method:** Patients with chronic, full-thickness rotator cuff tears (demonstrated on imaging) who were referred to one of two senior shoulder surgeons were enrolled in the study between October 2008 and September 2010. Patients participated in a comprehensive non-operative, home-based treatment program. After three months patients were defined as “successful” or “failed”. “Successful” patients were essentially asymptomatic and did not require surgery. “Failed” patients were symptomatic and consented to surgical repair. All patients were followed up at one year, two years, and five-plus years.
Results: Original results of our study showed that 75% of patients were treated successfully with non-operative treatment, while 25% went on to surgery. These numbers were maintained at two-year follow-up (previously reported) and five-year follow-up. At five+ years, 88 patients were contacted for follow-up. Fifty-eight (66%) responded. The non-operative success group had a mean RC-QOL score of 80 (SD 18) at previously reported two-year follow-up. At five-year follow-up this score did not decrease (RCQOL = 82 (SD 16)). Furthermore, between two and five years, only two patients who had previously been defined as “successful” became more symptomatic and underwent surgical rotator cuff repair. From the original cohort of patients, those who failed non-operative treatment and underwent surgical repair had a mean RC-QOL score of 89 (SD 12) at five-year follow-up. The operative and non-operative groups at five-year follow-up were not significantly different (p = 0.07).

Conclusion: Non-operative treatment is an effective and lasting option for many patients with a chronic, full-thickness rotator cuff tear. While some may argue that non-operative treatment delays inevitable surgical fixation, our study shows that patients can do extremely well over time.
**Paper Session:** COA Adult Reconstruction Knee 1: Primary

**87 - Effect of Soft Tissue Releases on Joint Space Opening in Total Knee Arthroplasty**

*Timothy A Burkhart, ON; Kevin Perry, US; Emily Dobbin, ON; Ben Herman, ON; James Howard, ON; Brent Lanting, ON*

**Purpose:** The purpose of this study was to determine the effect of sectioning the relevant soft tissues and a TKA on the medial and lateral knee joint gap.

**Method:** Twelve intact lower extremity cadaveric specimens (mean (SD) age 76.5 (11.6) years) were tested. A custom designed knee tensioner was developed that allowed the separate application of forces to the medial and lateral components of the knee. The distance between the bottom of the load cell and the top of a compression rod was measured with digital calipers (precision = 0.1mm). Loads of 100N and 200N were then applied to each compartment and the resulting displacement was measured. The two loads were applied to the knee in the following conditions: i) All soft tissues intact; ii) an arthrotomy; iii) ACL sectioned; iv) PCL sectioned; v) release of the mid-coronal tissues; and vi) TKA. Finally, tensions were applied for all conditions from 90° to 0° of knee flexion in 30° increments.

**Results:** There was a significant effect of soft tissue release on the magnitude of the gap at the 100N load application, such that there was an increase in the when the mid-coronal MCL release was performed compared to the intact (2.2mm) and arthrotomy (1.75mm) conditions. With respect to the 200N load application there was a statistically significant tissue release effect, where differences were detected between the mid-coronal MCL release and intact (3.04mm) and arthrotomy conditions (2.31mm). At the 100N load there was a significance increase in the gap compared to the intact knee. There was also a significant condition by knee angle interaction where the gap was approximately 4mm larger following the TKA compared to the intact condition when the knee was flexed at 90°. Furthermore, there was a statistically significant 4.8mm and 3.8mm difference between 90° and 0° and 60° and 0° of knee flexion respectively, for the TKA condition only. At the 200N load application the gap width increased significantly by 2.5mm following the TKA. Finally, there was a significant condition by knee angle interaction where the change in gap width increased significantly from the intact (7.54mm) to the TKA condition (13.88mm) at 90° of knee flexion. There was a statistically significant difference in the TKA condition between 60° and 0° of knee flexion.

**Conclusion:** Releasing the soft tissues increases the gap between the tibia and femur, when compared to the intact condition, with significance occurring only following the mid-coronal release. Furthermore, the TKA did not return the knee to its intact state as was evident by the significant difference between the TKA and intact conditions. This suggests that the resulting kinematics may not accurately match those pre-surgery resulting in un-physiological motion patterns and the possibility of early failure and revision.

**88 - Does Overstuffing the Patellofemoral Joint Lead to Adverse Outcomes in Total Knee Arthroplasty?**

*Jacob Matz, ON; David Morden, ON; Matthew Teeter, ON; Richard McCalden, ON; Steven MacDonald, ON; Edward Vasarhelyi, ON; James McAuley, ON; Douglas Naudie, ON; James Howard, ON; Brent Lanting, ON*
**Purpose:** Complications involving the patellofemoral joint are a source of anterior knee pain, instability, and dysfunction following total knee arthroplasty. “Overstuffing” the patello-femoral joint refers to an increase in the thickness of the patellofemoral joint after a total knee replacement compared to the preoperative thickness. While biomechanical studies have indicated that overstuffing the patellofemoral joint may lead to adverse clinical outcomes, limited clinical evidence exists to support this notion. The purpose of this study is to evaluate the effect of changing the thickness of the patellafemoral joint on functional outcomes following total knee arthroplasty.

**Method:** Our institutional arthroplasty database was used to identify 1347 patients who underwent a primary total knee arthroplasty between 2006 and 2012 with the same component design. Standard preoperative and postoperative anteroposterior, lateral, and skyline radiographs were collected and measured for patello-femoral overstuffing. These measurements included anterior patellar displacement, anterior femoral offset, and anteroposterior femoral size. These measurements were correlated with patient outcome data using WOMAC, KSS scores, and postoperative range of motion. Multiple linear regression analysis was used to assess the association between stuffing and functional outcomes.

**Results:** A total of 1031 patients who underwent total knee arthroplasty were included. Increased anterior patellar displacement, a measure of patellofemoral joint thickness, was associated with decreased WOMAC scores (p=0.02). Anterior femoral offset (p=0.210) and anteroposterior femoral size (p=0.091) were not significantly associated with patient functional outcomes. Postoperative range of motion (ROM) was not associated with patellofemoral stuffing (p=0.190).

**Conclusion:** The current study demonstrated that functional outcomes are adversely affected by patellofemoral overstuffing. Based on these results, caution is encouraged against increasing the thickness of the patellofemoral joint, particularly on the patellar side of the joint.

**89 - Learning Curve with a New Primary TKA Implant: A Worldwide Perspective with More than 2000 Patients**

James L. Howard, ON; Ivan Brenkel, Scotland; Chong Bum Chang, South Korea; Mark Clatworthy, New Zealand; William Hamilton, US; James Howard, ON; Verdonna Huey MS, US; Stephen Kantor, US; James Lesko, US; Ryan Nunley, US; Peter Verdonk, Belgium

**Purpose:** With the introduction of new technology in orthopaedics, surgeons must balance anticipated benefits in patient outcomes with challenges or complications associated with surgical learning curve for the technology. The purpose of this study was to determine whether surgeon learning curve with a new multi-radius primary TKA system and instruments designed to improve surgical team ease would impact clinical outcomes, surgical time, and complications.

**Method:** From November 2012 to July 2015, 2369 primary TKAs were prospectively enrolled in two multicenter studies across 50 sites in 14 countries with a new knee system (NEW-TKA) evenly balanced across four configurations: cruciate retaining or posterior stabilized with either fixed bearing or rotating platform (CRFB, CRRP, PSFB, PSRP). 2128 knees had a<1 year visit and 1189 had a minimum 1 year visit. These knees were compared to a reference dataset of 843 primary TKAs from three manufacturers in
the same four configurations with currently available products (CA-TKA). Demographics for NEW-TKA and CA-TKA were similar and typical for primary TKA. Operative times, clinical outcomes and a series of five patient reported outcomes were compared for NEW-TKA vs. CA-TKA. The first 10 New-TKA subjects for each surgeon were defined as learning curve cases (N=520) and were compared to all later subjects (N=1849). Patient reported outcome measure and clinical outcome analyses were covariate adjusted for patient demographics, pre-op assessment and days post-op.

**Results:** Mean (SD) surgical time for NEW-TKA learning curve cases was 79.1 (24.3) minutes, which reduced thereafter to 73.6 (24.3) (p=0.002). Beyond 10 cases, there was a continued reduction in NEW-TKA surgical time (R-Squared = 0.031). After 10 cases, surgical time was on par with the mean (SD) 71.9 (21.6) for CA-TKA (p=0.078). PROM outcomes of the first 10 learning curve cases for NEW-TKA were not statistically different from later cases at less than 1 year or later when adjusted for relevant covariates including configuration, patient demographics, pre-op functional status, and time post-op (p-values > 0.01). PROM outcomes for NEW-TKA vs. CA-TKA under the same covariate adjustments showed a trend favoring KOOS ADL, Symptoms, and Sport and Recreation subscores at minimum 1 year (p-values < 0.01). The incidence of intraoperative operative site complications was 1.3% for the NEW-TKA learning curve cases which was similar to the 0.6% rate for historical CA-TKA (p=0.231) and the intraoperative complication rate for the NEW-TKA later cases was consistent with learning curve cases (p=0.158).

**Conclusion:** The introduction of new implants into the market place needs to have adequate data to support that they are safe and effective. Except for a minor increase in surgical time during the first 10 patients, this study found that surgeon learning curve with this new primary TKA system does not adversely affect patient short term outcomes and complication rates.

**90 - Reproduction of Native Posterior Tibial Slope in Cruciate-retaining Total Knee Arthroplasty: Technique and Clinical Implications**

James P McAuley, ON; Phonthakorn Panichkul, ON

**Purpose:** The posterior tibial slope angle (PTS) in posterior cruciate retaining total knee arthroplasty influences the knee kinematics, knee stability, flexion gap, knee range of motion (ROM) and the tension of the posterior cruciate ligament (PCL). The current technique of using an arbitrary (often 3-5 degrees) PTS in all cases seldom will restore native slope in cruciate retaining TKA. Questions/Purposes: The primary objective was to determine if we could surgically reproduce the native PTS in cruciate-retaining total knee arthroplasty. The second objective was to determine if reproduction of native slope was significant- ie influenced clinical outcome.

**Method:** We evaluated the radiographic and clinical outcomes of a series of consecutive total knee arthroplasties using the PFC sigma cruciate-retaining total knee system in 215 knees. The tibial bone cut was planned to be parallel to the patient’s native anatomical slope in the sagittal plane. An “Angel Wing” instrument was placed on the lateral tibial plateau and the slope of the cutting guide adjusted to make the cutting block parallel to the patient’s native tibial slope. All true lateral radiographs of the knee were measured for PTS using a picture achieving and communication system (PACS). PTSs were measured with reference to the proximal tibial medullary canal (PTS-M) and the proximal tibial anterior
cortex (PTS-C). The knee ROM, Knee Society Score, Western Ontario and McMaster University Osteoarthritis Index (WOMAC) and SF-12 at the last follow-up were evaluated as clinical outcomes.

**Results:** The mean preoperative PTS-M was 6.9±3.3 degrees and the mean postoperative PTS-M was 7±2.4 degrees. The mean preoperative PTS-C was 12.2±4.2 degrees and the mean postoperative PTS-M was 12.6±3.4 degrees. There was no significant difference form the preoperative and postoperative PTS measurement in both techniques (p>0.05). We used an arbitrary 3 degrees as an acceptable range for PTS-M reproduction. The PTS-M was reproduced within 3 degrees in 144 knees (67%); designated as Group A. The 71 knees with a difference more than 3 degrees in (33%) were designated as Group B. Group A showed significantly larger gain in ROM compared with group B (p=0.04). Group A also had significantly better improvement in Knee society score and WOMAC score and SF-12 physical score when compare with group B (p<0.01).

**Conclusion:** Our modification of standard surgical technique reliably reproduced the native tibial slope in cruciate-retaining total knee arthroplasty. More importantly, reproduction of the patient’s native PTS within 3 degrees resulted in better clinical outcomes manifested by gain in ROM and knee functional outcome scores.

**91 – Quality of Recovery is Maintained for Patients Undergoing Outpatient Total Knee Arthroplasty**

Olivier Gauthier-Kwan, ON; Geoffrey F Dervin, ON; Johanna Dobransky, ON

**Background:** An outpatient TKA program was developed by integrating advances in analgesia, rehabilitation, and minimally invasive surgical techniques with the objective of improving value in elective total knee arthroplasty (TKA) while maintaining quality standards. Previous studies have established the safety of outpatient TKA in selected populations, but the literature is devoid of outcome measures in these patients. Our goal was to investigate the quality of recovery, patient satisfaction, and safety profile in the first 90 days undergoing outpatient TKA.

**Methods:** One hundred TKAs in 93 consecutive patients with end-stage arthritis of the knee candidate for primary TKA were enrolled in this prospective matched cohort study. Patients that underwent inpatient TKA (47 TKAs) were compared with patients that underwent planned outpatient TKA (53 TKAs). The following 28 day post-operative scores were recorded: quality of recovery (QoR-18) and pain scores by Numerical Rating Scale (NRS-11). Satisfaction with pain control (0 to 10) and quantity of opioid use was collected. Secondary outcome measures of 90-day complications, readmissions, and emergency department (ED) visits were recorded.

**Results:** Ninety-six percent of patients planned for outpatient TKA met our defined multidisciplinary criteria for same-day discharge. QoR-18 at post-operative day one was statistically higher in the outpatient TKA group. Otherwise, outcome measures were not statistically different between the 2 groups. Two patients required overnight admission: 1 for extended motor-block and 1 for vasovagal syncope. There were 7 ED visits in the in the outpatient group and 4 in the inpatient group. One outpatient was admitted for irrigation and debridement with liner exchange for an acute infection 2 weeks post-operatively. One inpatient required manipulation under anesthesia at six weeks post-operatively.
Conclusion: Outpatient TKA in selected patients produced a post-operative quality of recovery and patient satisfaction similar to that of inpatient TKA. Our results support that outpatient TKA is a safe alternative that should be considered due to its potential cost-savings and comparable recovery.

Level of Evidence: Level II (Prospective cohort study)

92 - Kinematically Aligned Total Knee Arthroplasty, a Proposed Algorithm
Abdulaziz Almaawi, QC; Khalid Alsheikh, QC; Vincent Masse, QC; Martin Lavigne, QC; Pascal-André Vendittoli, QC

Purpose: Total knee arthroplasty (TKA) is the definitive treatment of choice for knee joint degeneration. The most common method applied in TKA is to place the knee in neutral mechanical alignment. In order to get a mechanically aligned knee, the tibial and femoral components are implanted perpendicular to the mechanical axis of the tibia and femur. To insure that the flexion space is rectangular (ligament balanced), femoral component needs to be externally rotated. When neutral mechanical alignment is restored, in bipedal standing position the mechanical axis of the lower limb goes through the center of the knee. With this “mechanical” alignment technique, normal knee anatomy is modified in all its three dimensions and changes the joint kinematics. On the other hand, the mechanical TKA technique has been proven to provide good mid to long term implant survivorship. Although well fixed, patients may report high levels (20%) of dissatisfaction. One theory is that putting the knee in neutral mechanical alignment may be responsible for these unsatisfactory results. Modifying Knee anatomy during mechanical TKA may also impact ligament balance, patellar tracking and quadriceps function. Kinematic TKA has gained interest in recent years; it aims to resurface the knee joint by replacing only the amount of cartilage and bone thickness/loss equivalent to implant thickness. This would results in preservation of natural femoral flexion axis about which the tibia and patella articulate, recreating the native knee. With the removal of osteophytes, the original ligament balance can be restored without additional release. That’s being said, it remains the question of whether all patients are suitable for kinematic alignment. Some patients’ anatomy may be inherently biomechanically susceptible to the earlier degenerative disease. Re-establishing native anatomy in these patients may result in subsequent implant failure. Also, some patients’ anatomy has been changed due to trauma, childhood deformity or previous surgeries. The senior author (PAV) has been performing Kinematic TKA since 2011, and has developed an algorithm in order to better predict which patient may benefit from this technique. The algorithm aims to modify patients’ anatomies, especially when recreating the patient anatomy would be unsuitable for long-term survival. Safe range algorithm was defined as the combination of the following criteria: -Independent tibial and femoral cuts within ± 5° of the bone neutral mechanical axis. -Combined coronal alignment within ± 3° of the Hip-knee-Ankle (HKA) neutral axis. The purpose of this study is to verify the applicability of the proposed safe range algorithm on a large sample of individual scheduled for TKA.

Method: Lower limb CT scans from 4884 consecutive patients scheduled for TKA arthroplasty were analyzed. These exams were performed for patient-specific cutting blocks production (My Knee®, Medacta, Switzerland). The anatomical landmarks used to create accurate CT-based preoperative planning include: Hip center, Ankle center, distal femoral center (Point in the middle of intercondylar
notch & correspond to most distal point of the trochlea), proximal tibial center (midpoint between medial and lateral eminences). These landmarks will determine the mechanical axis of bone for the femur and tibia. Cartilage is not included. No restrictions could be applied on preoperative diagnosis, previous surgeries or ethnic group. Definitions: Only the coronal plane was considered in the analysis. The mechanical angle of femur and tibia was defined as the angle between the axis perpendicular to the mechanical axis of the bone and the axis identifying the orientation of the articulating surface (e.g. for the tibia the line connecting the lowest point of the articular surface of the two plateaus). The combined mechanical angle (CMA) was defined as the algebraic sum of the mechanical angles of tibia and femur. This angle represents the expected postoperative HKA for kinematic TKA with no anatomical correction. In this study, it was assumed that negative angles correspond to a valgus deformity, whereas positive angles correspond to a varus deformity. Population description & Tested Algorithm: We wanted to test the safe range for kinematic TKA for the planned distal resection of the femur and tibia. Safe range was defined as the combination of the following criteria: Independent tibial and femoral cuts within ± 5° of the bone neutral mechanical axis. Combined coronal alignment within ± 3° of the Hip-knee-Ankle (HKA) neutral axis. This safe range has been developed from studies that showed no adverse outcome of TKA where the CMA was ±3°. Algorithm was applied in two steps. For the knees outside the proposed safe range, tibial and femoral mechanical angles were corrected independently by setting them to a closer limit value to ± 5°. After the independent femoral or tibial corrections, if CMA was >3°, the cases were divided into three groups and further corrected as follows: a) Cases with CMA more than 3° of valgus, valgus femur and varus tibia: tibial angle was increased to obtain & -3° of the CMA. b) Cases with CMA more than 3° of varus, varus tibia and valgus femur: tibial angle was reduced to obtain +3° of the CMA. c) Cases where both femur and tibia had anatomy oriented in varus or valgus and combined angles resulted in CMA >3 degrees (for example: femur 3 degrees varus and tibia 6 degrees varus). The senior author manages these cases individually; we decided to categorize them as “unusual anatomies” and not to include them in further analyses.

Results: The preoperative tibial mechanical angle average 2.9 degrees in varus (range: -20.5 to +20.5, SD 2.9), femoral mechanical angle averaged 2.7 degrees in valgus (range -15.5 to +11, SD 2.7) and overall HKA averaged of 3.3 in valgus (range -28 to +26, SD 5.65). There were 2475 (50.7%) knees out of 4884, with femur and tibia of < 5 degrees valgus/varus and within CMA ±3° without any anatomical corrections. In second stage, femoral and tibial mechanical angles outside the chosen safe range (1615 cases, 33.1%) were corrected independently by setting them to the closer limit value (5 degrees varus/valgus): 801 cases (16.4%) required correction of the tibial angle only; 694 cases (14.2%) required correction of the femoral angle only; and 120 cases (2.5%) required correction of both tibial and femoral angle. The average tibial correction was -1.62° and the average femoral correction was +1.63°. After these corrections, there were 3334 cases (68.3%) within the safe range of CMA (±3°). We were left with 1550 (31.7%) cases with CMA outside the ±3° range (47.8% in excessive valgus and 52.2% with excessive varus). The next step was to adjust the tibial mechanical angle to reach CMA of ±3°. In 375 cases (7.2%) with CMA of more than 3° of valgus, tibial mechanical angle was increased to reach the safe zone. In 353 cases (7.7%) with CMA of more than 3° of varus, tibial mechanical angle was reduced to reach the safe zone. The average correction of the tibial mechanical angle was 1.1° (varus or valgus). At this stage, a total of 4062 cases (83.2%) were successfully been evaluated using the proposed protocol to reach a
The remaining 822 cases (16.8%) could not be managed in the proposed algorithm because of their unusual anatomical combination of femur and tibia. In most cases, both bones had varus or valgus anatomicies precluding correction of one bone by reducing deformity on the other bone (for example, a femur with valgus >5 degrees with a neutral tibia). In such cases, senior author practice is to balance corrections on both sides of the joint depending on each patient's specific anatomy. Further step could be added to the algorithm to include such situations.

Conclusion: TKA optimal alignment has been a matter of debate. Mechanical TKA has provided good mid to long-term results. However, associated knee anatomy modifications done in mechanically aligned knee may be linked to some of the unsatisfactory results and the lack of normal knee function. Kinematic TKA has emerged as an alternative that would restores/preserves knee function and offer better clinical results in comparison to mechanical alignment TKA. In this study, we tested a proposed algorithm to perform kinematic alignment TKA avoiding preservation/restoration of some extreme anatomicies that might not be suitable for TKA long-term survivorship. A total of 2475 of 4884 knees (50.7%) were falling within the proposed safe range algorithm without any anatomical corrections and 4062 of 4884 cases (83.2%) were successfully eligible for our proposed safe range algorithm (femur or tibia within ±5° and CMA ±3°) for kinematic TKA. One limitation of this study is that our database does not provide pre-operative diagnoses for arthroplasty or if there were any other extra-articular deformities. In conclusion, kinematically aligned TKA may be a promising option to improve normal knee function restoration and patient satisfaction. Until we have valuable data confirming the compatibility of all patients’ pre-arthritic anatomicies with TKA long-term survivorship, we believe that kinematically alignment should be performed within some limits. With our proposed protocol, eight out of ten patients would fall safely in a range of kinematic TKA not associated with unfavourable long-term survivorship. Further studies with Radiostereometry or longer follow up might help determine if all patients’ anatomicies are suitable for Kinematic TKA.

Purpose: Total knee arthroplasty (TKA) is recognized as an effective treatment for end-staged knee osteoarthritis. Up to 20% of these patients is unfortunately unsatisfied due to anterior knee pain from unknown origin (Bourne and al. 2010). The aim of this study is to compare knee 3D kinematics during gait of patients with anterior knee pain after TKA to an asymptomatic TKA group. Our hypothesis is that the painful TKA group would exhibit known kinematics characteristics during gait that increase patellofemoral (PF) stresses (i.e. dynamic flexion contracture, valgus alignment, valgus collapse or a quick internal tibial rotation movement) compared to the TKA asymptomatic group

Method: Thirty-eight patients (45 knees) were recruited 12-24 months post-surgery done by one of three experienced orthopaedic surgeons (31 unilateral TKA and seven bilateral TKA, all using the same knee implant). Patients were divided according to their KOOS pain score (with a cut-off at 6/20 to be included in the painful group). The KOOS questionnaire was also used to assess activities of daily living, symptoms, sports and quality of life. A complete clinical and radiological work up was done on the
painful group to exclude those with known explanation for pain (i.e. loosening, malrotation, infection and clinical instability). 3D knee kinematics during treadmill walking was captured and computed using the KneeKGTM system.

**Results:** For the painful and asymptomatic groups, demographic results show respectively: age of 64.4 ± 7.6 and 69.8 ± 8.3 years, BMI of 31.9 ± 5.0 and 28.1 ± 3.6 kg.m⁻², speed of 1.8 ± 0.6 and 1.67 ± 0.5 miles/h., and 50% of women in each group. Only age and BMI showed to be statistically different between groups. The painful TKA group exhibited a valgus alignment when walking (at initial contact and during stance, p<0.001). No significant difference has been put forward for the flexion/extension and internal/external tibial rotation.

**Conclusion:** Since a higher valgus alignment increases the Q angle, which lateralize the patella and increases PF stresses, results provide new insight on origin of symptoms. Conservative treatments for PF pain syndrome have shown to address the valgus alignment and improve symptoms, therefore the next step will be to assess the impact on pain level and alignment during gait of a personalized conservative management for the painful TKA group. Additionally, a study assessing the change in the radiological and dynamic alignment from pre to post surgery could bring valuable insight on the impact of surgical procedure on anterior knee pain.

**94 - Evaluation of the use of Spinal Epimorph in Total Knee Arthroplasty: A Prospective Double-blind Randomized Control Trial**

**Colleen Weeks, AB; Lyndsay Somerville, ON; Joel Phillips, ON; Sugantha Ganapathy, ON; James Howard, ON**

**Purpose:** The use of spinal anesthesia with adjuvant intra-thecal opioids has been commonly used in total knee arthroplasty without documented clinical benefit. It has been associated with a potential increase in side effects, including nausea, vomiting, pruritus, urinary retention and oxygen usage. This double-blinded RCT investigated whether the addition of epimorph to spinal anesthesia in patients undergoing total knee arthroplasty resulted in superior pain control and decreased narcotic consumption without also causing an increase in postoperative complication rates.

**Method:** We performed a prospective double-blind trial in patients undergoing primary total knee arthroplasty (TKA). Patients were randomized to receive either spinal anesthesia alone or spinal anesthesia with epimorph (150 ug). All patients received infiltration of a local anesthetic cocktail intraoperatively. Both the study patients and staff measuring outcomes were blinded to the experimental treatment received during data collection. Postoperatively, visual analogue scale (VAS) for pain was recorded at 6, 12, 18, 24, 36 and 48hrs and a final value at 1 week. Narcotic use, Foley insertion, oxygen requirements, nausea, vomiting and pruritus were recorded during the course of hospitalization.

**Results:** Forty-one patients were randomized into each of the spinal with epimorph and spinal alone treatment arms. The groups showed no significant differences in BMI, age, and gender distribution. In the first 12 hours postoperatively there was no difference in VAS for pain between the two groups, however there were significantly lower pain scores in the spinal alone patients at 18 hours (p=0.002), 24
hours (p=0.04) and 48 hours (p = 0.03) compared to the spinal with epimorph group. Narcotic usage was greater in the spinal group during the first 6 hours postoperatively, but beyond this time point narcotic usage was similar between the two groups. Additionally, there was a statistically significant increase in rate of complications with spinal epimorph including nausea (p=0.037) and pruritus (p=0.024). The incidence of urinary retention was greater in the spinal epimorph group, however this did not reach statistical significance.

**Conclusion:** This study demonstrates no clinical benefit with the addition of intra-thecal opioids to spinal anesthetic in primary TKA. In addition to a failing to reduce VAS pain scores and overall narcotic consumption, increased complication rates were seen. For these reasons, this study does not support the use of epimorph in addition to spinal anesthesia for pain control in TKA.

**95 - Quality Improvement Programs That Reduce Length of Stay for Total Joint Arthroplasty Do Not Result in Higher Readmission Rates**

Jason R Werle, AB; Hoa Khong, AB; Chris Smith, AB

**Purpose:** Many hospitals and orthopaedic surgery teams across Canada have instituted quality improvement (QI) programs for hip and knee arthroplasty. One of the common goals is to reduce hospital length of stay (LOS) in order to improve operational efficiency, patient flow and, by achieving this, provide improved access for patients to arthroplasty surgery. A common concern among surgeons and care providers is that hospital readmission rates will increase if LOS is significantly reduced. This study assesses the relationship between LOS and readmission rates in Alberta over a six year period during a focused QI initiative targeting LOS.

**Method:** Data from all patients undergoing primary elective total hip or knee arthroplasty in Alberta between 2010 and 2015 was captured through a provincial QI program. Patient characteristics captured included age, gender, joint replaced, and pre-surgical co-morbidities. Patient LOS and all-cause hospital readmissions within thirty days from the initial discharge were captured through provincial data repositories, including the Discharge Abstract Database (DAD), operating room information systems, electronic medical records, and comorbidity risk grouper (CRG) data. Three longitudinal analyses were performed: 1) the crude and risk adjusted length of stay and 30-day readmission rates were calculated, 2) the population was grouped into two 3-year subsets and compared using t-test (acute LOS) and chi-square (30-day readmission), and 3) a multivariable regression analyses was performed to determine the rate of change and statistical significance in acute LOS and 30-day readmission between the two time periods.

**Results:** The number of patients undergoing elective lower extremity arthroplasty in the province during the six-year study period (2010-2015) was 48,760 patients. Fifty-nine percent were female and forty-one percent were male. Mean age of the cohort was 66.9 years. Thirty-nine percent of patients had a total hip arthroplasty and 61% had a total knee arthroplasty. Forty-five percent of patients had no pre-surgical risk factors, 27% had one risk factor, and 28% of the patients had 2 or more risk factors. During the quality improvement program risk-adjusted length of stay improved from a mean of 4.82 days (in 2010-2012) to 3.90 days (in 2013-2015) (p<0.01). Controlling for differences in age, sex, joint replaced,
and pre-surgery risk factors, the acute LOS declined by 0.32 days between the two time periods (p<0.001).

**Conclusion:** Quality improvement programs that target reduced LOS can avoid increasing 30-day hospital readmission rates. This has significant implications for inpatient resource utilization for lower extremity arthroplasty surgery and for improving patient flow.

**96 - Ultrasound Guided Motor Sparing Knee Blocks for Postoperative Analgesia Following Total Knee Arthroplasty: A Randomized Blinded Study**

*James L. Howard, ON; Rakesh Sondekkoppam Vijayashankar, ON; Olawale Sogbein, ON; Suguntha Ganapathy, ON; David Johnston, ON; Dianne Bryant, ON; Brent Lanting, ON; Edward Vasarhelyi, ON; Steven MacDonald, ON*

**Purpose:** Pain immediately following total knee arthroplasty (TKA) is often severe and can inhibit patients’ rehabilitation. Recently, adductor canal blocks have been shown to provide adequate analgesia and spare quadriceps muscle strength in the early postoperative period. We devised a single injection motor sparing knee block (MSB) by targeting the adductor canal and lateral femoral cutaneous nerve with a posterior knee infiltration under ultrasound. Our primary objective was to evaluate the analgesia duration of the MSB in comparison to a standard periarticular infiltration (PAI) analgesia using patients’ first rescue analgesia as the end point. Secondary outcomes measured were quadriceps muscle strength and length of stay.

**Method:** We randomized 82 patients scheduled for elective TKA to receive either the preoperative MSB (0.5% ropivacaine, 2.5ug/ml epinephrine, 10mg morphine, and 30mg ketorolac) or intraoperative periarticular infiltration (0.3% ropivacaine, 2.5ug/ml epinephrine, 10mg morphine, and 30mg ketorolac). Duration of analgesia, postoperative quadriceps power, and length of stay were evaluated postoperatively.

**Results:** Analgesic duration was found to be significantly different between groups. The MSB had a mean duration of 18.06 ± 1.68 hours while the PAI group had a mean duration of 9.25 ± 1.68 hours for a mean difference of 8.8 hours (95% CI 3.98 to 13.62), p<0.01. There were no significant differences between groups in quadriceps muscle strength power at 20 minutes (p=0.91) or 6 hours (p=0.66) after block administration. Length of stay was also not significantly different between the groups (p=0.29).

**Conclusion:** Motor sparing blocks provide longer analgesia than patients receiving periarticular infiltration while not significantly reducing quadriceps muscle strength or increasing length of hospital stay.

**97 - Thirty Day Complications of Conventional and Computer-assisted Total Knee and Total Hip Arthroplasty: Analysis of 104,550 Patients in ACS-NSQIP Database**

*Ahmed Aoude, QC; Sultan Aldebeyan, QC; Anas Nooh, QC; Michael H. Weber, QC; Micheal Tanzer, QC*

**Purpose:** Computer assisted surgery (CAS) has gained popularity in orthopaedics for both total knee (TKA) and total hip arthroplasty (THA) in the past decades as a stereotactic device that provides the surgeon with real-time feedback on implant position based on electromagnetic or infrared based
instruments. The purpose of this study was to assess the effect of CAS on 30-day complication rates following THA and TKA.

**Method:** The American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database was used to identify all patients that underwent THA and TKA from 2011 to 2013, as well as any complication they had within 30-days of their surgery. Univariate and multivariate regression analysis was used to compare the post-operative complications in patients whose surgery involved the use of CAS with those by conventional surgical techniques.

**Results:** We identified 104,550 patients who had THA (42,275 patients) and TKA (62,275 patients) procedures in the database between 2011 and 2013. Computer Assisted Surgery was used in 1,120 THA and 2,173 TKA procedures. There were higher overall adverse events (OR 1.40, CI: 1.22-1.59) in the Conventional group when compared to CAS for TKA. The rate of overall minor events (OR 1.38, CI: 1.21-1.58) and requirements for blood transfusion (OR 1.44, CI: 1.25-1.67) were higher in the Conventional group compared to the CAS group for TKA. However, rate of re-operation was significantly higher in the CAS group for TKA (OR 1.60, CI: 1.15-2.25). The results also showed higher overall adverse events (OR 2.61, CI: 2.09-3.26) in the Conventional group when compared to CAS for THA. The rate of overall minor events (OR 2.72, CI: 2.16-3.42) and requirements for blood transfusion (OR 3.27, CI: 2.52-4.25) was higher in the Conventional group whereas superficial wound infections (OR 0.46, CI: 0.46-0.81) were shown to be higher in the CAS group. The result also showed slightly longer operative times in CAS for both THA and TKA.

**Conclusion:** This study analysed a large patient database involving multiple institutions and surgeons and found that, overall, the use of CAS in primary total hip and total knee arthroplasty reduced the number of adverse events in the first 30-days postoperatively, compared to conventional surgical techniques. However, CAS was associated with an increased number of reoperations, superficial infections and operating time. The clinical benefits and disadvantages of CAS should be considered by arthroplasty surgeons when determining the potential benefit-cost ratio of this technology.
98 - Day 1 Discharge After Total Hip Replacement – Impossible or Becoming a Reality?
Sanjay Gupta, ON; Paul Byrne, Scotland; Graeme Hopper, Scotland; Angela Deakin, Scotland; Jason Roberts, Scotland; Andrew Kinninmonth, Scotland

Purpose: This aim of this study was to identify common factors in patients with the shortest length of hospital stay following total hip arthroplasty (THA). This would then allow a means of targeting suitable patients to reduce their length of stay.

Method: This was a retrospective cohort study of all patients undergoing primary THA at our institution between September 2013 and August 2014. Demographic data were collected from the patient record. The cohort was divided into those discharged to home within two days of operation and the rest of the THA population. The demographics (age, gender, ASA grade, body mass index (BMI), primary diagnosis, socioeconomic status (Scottish Index of Multiple Deprivation, SIMD and SIMD health domain) were compared between groups. In addition for the early discharge group information on comorbidities, family support at home and independent transport were collected.

Results: The study cohort was 1292 patients. 119 patients were discharged home on the first post-operative day. Those discharged earlier were on average younger (p<0.0001), more likely to be male (p<0.0001) and had a lower ASA grade (p<0.00001). Other demographics did not differ between groups. Patients who were discharged early also appeared to have few comorbidities (Diabetes 5.9%, Cardiac disease 7.6%, Respiratory disease 9%), high levels of family support at home (95%) and high levels of independent transport arrangements (97%).

Conclusion: Factors associated with those patients with the shortest lengths of stay were identified. Such factors could be used to target patients who are suitable for streamlined recovery programmes aimed at early discharge after THA and assist with service planning.

99 - Too Much for Too Little: Cost Analysis of Current Total Hip Arthroplasty Follow Up Practices
Chris A Small, NL; Andrew Furey, NL

Purpose: Total hip arthroplasty (THA) is a common and extremely beneficial procedure that is being performed more often as the population ages. Current THA follow-up guidelines require large amounts of resources and may not justify their cost with increased patient outcomes. Most problems that would require THA revision will cause symptoms. Late-presenting asymptomatic THAs that are found to require revision are complicated and expensive to address and often lead to poor patient outcomes. Follow-up visits for THA patients are essentially a screening tool to identify asymptomatic THAs that require revision. The rate of asymptomatic THA revision and the subsequent cost of screening for them is not well reported in the literature. Given the relative shortage of orthopaedic resources, efficient use of clinic time should be a priority and inefficient practices should be identified and changed.

Method: We calculated the rate of asymptomatic hip revisions over the first twenty years of THA ownership. We further calculated the cost of a single visit to the orthopaedic clinic for follow up of a
THA. Finally, we calculated the cost savings of decreasing the follow-up schedule to a total of three visits.

**Results:** The cost savings of foregoing the screening to identify one asymptomatic THA requiring revision is CAD $1.2 million.

**Conclusion:** Asymptomatic THAs requiring revision are rare and, as such, require a large amount of follow up to diagnose. As a screening tool, regular orthopaedic follow up of THA is an inefficient use of resources. Current follow-up guidelines are cost-prohibitive and should be made much less frequent in order to save resources.

**100 - Serum Cytokine Profiles Are Distinct Between Patients with Hip or Knee Osteoarthritis and Associated with Hip Pain**

**Guomin Ren, AB; Ian Lutz, SK; Pamela Railton, AB; Jenelle McAllister, AB; Preston Wiley, AB; James Powell, AB; Roman Krawetz, AB**

**Purpose:** To identify the differences in inflammatory profiles between hip OA, knee OA and non-OA control cohorts and investigate the association between cytokine expression and clinical outcome measurements, specifically pain.

**Method:** A total of 250 individuals were recruited in three cohorts (100 knee OA, 50 hip OA, 100 control). Serum was collected and inflammatory profiles analyzed using the Multiplex Human Cytokine Panel (Millipore) on the Luminex 100 platform (Luminex Corp., Austin, TX). The pain, physical function and activity limitations of hip OA cohort were scored using the WOMAC, SF-36, HHS and UCLA scores. All cytokine levels were compared between cohorts individually using Mann–Whitney–Wilcoxon (MWW) test with Bonferroni multiple comparison correction. Within hip OA cohorts, the effect of hip alignment (impingement and dysplasia) and radiographic grade (Kellgren and Lawrence grade, K/L grade) on cytokine levels were accessed by MWW test. Spearman’s rank correlation test used to assess the association between cytokines and pain levels.

**Results:** The three cohorts showed distinct inflammatory profiles. Specifically, EGF, FGF-2, MCP-3, MIP-1a, IL-8 were significant different between knee and hip OA; FGF-2, GRO, IL-8, MCP-1, VEGF were significant different between hip OA and control; Eotaxin, GRO, MCP-1, MIP-1b, VEGF were significant different between knee OA and control (p-value < 0.0012). For hip OA cohorts, cytokines do not differ between K/L grade three and K/L grade four or between patients that displayed either impingement or dysplasia. Three cytokines were significant associated with pain: IL-6 (p-value = 0.045), MDC (p-value = 0.032) and IP-10 (p-value = 0.038).

**Conclusion:** We have demonstrated that differences in serum inflammatory profiles exist between hip and knee OA patients. These differences suggest that OA may include different inflammatory subtypes according to affected joints. We also identified that the cytokine IL-6, MDC and IP-10 are associated with pain level in hip OA patients. These cytokines might help explain the inconsistent of presentation of pain with radiographical severity of OA joints. Future studies are needed to validate our findings and then to
understand the following questions: (1) how differently affected joints are reflected in systematic biomarkers; (2) how these cytokines are biologically involved in the OA pain pathway.

101 - Comparing the Anterior, Posterior, and Lateral Approach: Gait Analysis in Total Hip Arthroplasty

Stephen Petis, ON; Edward Vasarhelyi, ON; Brent Lanting, ON; Ian Jones, ON; Trevor Birmingham, ON; James Howard, ON

Purpose: Total hip arthroplasty (THA) is the most effective treatment modality for severe arthritis of the hip. Patients report excellent clinical and functional outcomes following THA, including subjective improvement in gait mechanics. However, few studies in the literature have outlined the impact of surgical approach on gait kinetics and kinematics. The purpose of this study was to determine the impact of surgical approach for THA on quantitative gait analysis.

Method: Thirty patients undergoing THA for primary osteoarthritis of the hip were assigned to one of three surgical approaches (10 anterior, 10 posterior, and 10 lateral). A single surgeon performed each individual approach. Each patient received standardized implants at the time of surgery (cementless stem and acetabular component, cobalt chrome femoral head, highly cross-linked liner). Patients underwent 3D gait analysis pre-operatively, and at 6- and 12-weeks following the procedure. At each time point, temporal gait parameters, kinetics, and kinematics were compared. Statistical analysis was performed using one-way analysis of variance.

Results: All three groups were similar with respect to age (p=0.27), body mass index (p=0.16), and the Charlson Comorbidity Index (p=0.66). Temporal parameters including step length, stride length, gait velocity, and percent stance and swing phase were similar between the groups at all time points. The lateral cohort had higher pelvic tilt during stance on the affected leg than the anterior cohort at 6-weeks (p=0.033). Affected leg ipsilateral trunk lean during stance was higher in the lateral group at 6-weeks (p=0.006) and 12-weeks (p=0.037) compared to the other cohorts. The anterior and posterior groups demonstrated an increased external rotation moment at 6-weeks (p=0.001) and 12-weeks (p=0.005) compared to the lateral group.

Conclusion: Although temporal parameters were similar across all groups, some differences in gait kinematics and kinetics exist following THA using different surgical approaches. However, the clinical relevance based on the small magnitude of the differences remains in question.

102 - Infections After Blood Transfusion in Primary Total Joint Arthroplasty

Ashish Taneja, AB; Hoa Khong, AB; Rajrishi Sharma, AB; Cristopher Smith, AB; Pam Railton, AB; Shannon Puloski, AB; Kelly Johnston, AB; Jim Powell, AB

Purpose: Patients undergoing Joint Arthroplasty received a significant proportion of blood transfusions. In this study, we compared the risk of Deep Infection, and Superficial Infection post operation following Primary Total Hip or Knee replacement in blood-transfused and non-blood-transfused patients.

Method: Cohort of patients who underwent primary total Hip or Knee Arthroplasty from April 2012 to March 2015 in Alberta. Patient characteristics, comorbidity, received blood transfusion were collected from electronic medical records, operating room information systems, discharge abstract database,
provincial clinical risk grouper data. Deep Infection and Superficial Infection were captured from Provincial Surgical Site Infection Surveillance data. Deep Infection include deep incisional and organ/space infections. Logistic regression analysis were used to compare Deep Infection and Superficial Infection in blood-transfused and non-blood-transfused cohorts, and risk-adjusted for age, gender, procedure type, and co-morbidities.

**Results:** Our study cohort contains 27891 patients, with mean of age at admission was 66.3±10.4, 57.5% female, 49.3 % had 1 or more comorbidities. 58.8% underwent Knee Replacement. 11.1 % received blood transfusion during hospital stay (Total Hip Replacement (THR) =13.1% and Total Knee Replacement (TKR) =9.7 %). 1.1 % had Deep Infection (THR=1.4% and TKR=0.9%) and 0.5% had Superficial Infection (THR=0.5% and TKR=0.5%). Blood-transfused patients got 1.7 % Deep Infection and 1.0% Superficial infection. Non-blood-transfused patients got 1.0% Deep Infection and 0.5 % Superficial infection. Controlling for age, gender, procedure type, and co-morbidities, the odds of Deep Infection were 1.6 times higher for blood-transfused patients than for non-blood-transfused patients (adjusted odds ratio [OR]=1.6, 95% confidence interval [CI] [1.2-2.2], p=0.004). The odds of Superficial Infection were 2.0 times higher for transfused patients (adjusted OR=2.0, 95% CI [1.3-3.0], p=0.002).

**Conclusion:** Blood transfusion increases Deep Infection and Superficial Infection post-surgery following Primary Total Knee or Hip Replacement. This finding suggests to reduce the unnecessary blood transfusion for patients considering Joint Arthroplasty. Reducing the blood transfusion will save the inpatient cost and decrease the infective complications post-surgery in Hip or Knee Arthroplasty patients.

103 - T1rho Advanced Cartilage Mapping Correlates with Surgical Outcome of Patients Treated for Cam Type Femoro-acetabular Impingement

Paul Beaulé, ON; Helen Anwander, ON; Melkus Gerd, ON; Kawan S Rakhra, ON; Manisha Mistry, ON

**Purpose:** Cam-type femoral acetabular impingement (FAI), is a common structural hip deformity and thought to be a leading cause of early hip osteoarthritis. Although patients who undergo surgical correction notice improved clinical function it is unclear what impact this has on the overall health of the cartilage. T1rho MRI cartilage mapping has been shown to be a reliable imaging technique to assess the proteoglycan (PG) content potentially serving as a biomarker. This study analyzes post surgical changes in T1rho levels in hip joints treated with cam FAI.

**Method:** Eleven patients with a mean age of 38 (all males) underwent pre and post T1Rho Cartilage mapping of their hips at a mean time of 20 months post surgical intervention. The acetabulum was spatially divided into 4 main regions of interest (ROI), with levels of T1Rho in cartilage quantified as a whole and in each spatial segment. T1Rho signal is inversely correlated with level of PG content.

**Results:** All patients demonstrated loss of PG content on pre-op imaging with a T1Rho of 33.5ms+2.6ms. Preop T1rho levels were found to significantly correlated with the difference between pre-op and post-op T1rho in entire hip cartilage (R: 0.73; p=0.016). This correlation was reflected both in the anterolateral quadrant (R: 0.86; p=0.002), and in the posteriosuperior quadrant (R:0.70; p=0.035). Additionally, significant correlation was found between improvement of WOMAC pain score over time,
and difference of T1rho values over time in the most lateral 3mm slice of the anterolateral quadrant (R: 0.81; p=0.045). Significant correlation was found between pre-op alpha angle at 1:30 and difference between pre-op and post-op total cartilage T1rho content (R: -065; p=0.038).

**Conclusion:** T1Rho Cartilage mapping of the hip is a useful biomarker in the assessment of the surgical management of Cam type FAI. This preliminary data provides some evidence that surgical correction of the deformity can help minimize disease progression.

104 - Conjoint Tendon Release in Direct Anterior Total Hip Arthroplasty: Does it Matter?
Reina Yao, ON; Brent Lanting, ON; James Howard, ON

**Purpose:** The direct anterior (DA) approach for total hip arthroplasty (THA) has become increasingly popular in North America. With experience, exposure of both the acetabulum and femur can be achieved similar to those in other approaches. In cases of difficult femoral exposure, the conjoint tendon of the short external rotators can be released to improve visualization. The effect of conjoint tendon release has not been previously explored in regards to overall outcomes, or postoperative pain. The goal of this study was to evaluate 1) the length of stay and inpatient pain medication requirements of patients undergoing DA THA on the basis of conjoint tendon release, and 2) whether conjoint tendon release influenced functional outcomes.

**Method:** We conducted a retrospective chart review of all cases of primary DA THAs conducted by single surgeon at LHSC University between August 2012 and July 2015. Patient demographics, bilateral THA cases, intraoperative conjoint tendon or other soft tissue releases, intra-operative complications, and length of stay (LOS) were evaluated for all cases. Inpatient pain medication data was available for all cases from Apr 2014 onwards. One year functional outcome scores, including WOMAC and Harris Hip Scores (HHS), were evaluated for all cases before August 2014. Six-week and three-month functional outcome scores were available and evaluated for a subset of cases. All data was analyzed with multiple linear regression.

**Results:** Three hundred and twelve cases of primary DA THAs were identified, of which 29 were concurrent bilateral THAs. One hundred and eighty cases included a conjoint tendon release, while 29 cases had other soft tissue releases (tensor fascia lata). Mean age and BMI were 64.9±11.5 years and 29.0±5.3 respectively. Mean LOS was 1.3±1.1 days, with age, bilateral THA, non-conjoint tendon soft tissue release, and intra-operative complications being predictive of LOS (p<0.05). Pain medication data was available for 107 cases, of which 11 were concurrent bilateral THAs. Sixty four cases included a conjoint tendon release, while one case had other soft tissue releases. Mean daily morphine equivalent dose (MED) narcotic use was 43.2±48.2mg, with age being a negative predictor of narcotic use (p<0.05). BMI was a negative predictor of one year HHS pain, HHS total, and all WOMAC subcategory scores, while age was a negative predictor of one year HHS function and HHS total scores (p<0.05). None of the variables were predictive of six-week and three-month functional outcome scores. Conjoint tendon release was not predictive of LOS, inpatient pain medication requirements, or outcome scores.

**Conclusion:** Conjoint tendon release did not affect postoperative pain, LOS, or functional outcomes. Given that conjoint release improves femoral exposure, intraoperative thresholds for conjoint release

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should be low. The effect of intraoperative release of other soft tissues is uncertain, as this increased 
LOS but not postoperative pain.

105 - A Prospective Cohort Study Investigating Functional Recovery in Patients with Osteoarthritis 
Following Total Hip Arthroplasty using a Direct Anterior versus Direct Lateral Surgical Approach 
Bryn Zomar, ON; Susan Muir, ON; Dianne Bryant, ON; Edward Vasarhelyi, ON; James Howard, ON; Brent 
Lanting, ON

Purpose: The purpose of our study was to prospectively examine early functional differences in gait 
between the direct anterior and direct lateral surgical approaches for total hip arthroplasty over the first 
three months postoperatively.

Method: Forty participants were prospectively enrolled to either the direct anterior (20 patients) or 
direct lateral group (20 patients) based on their surgeon’s expertise. Outcome measures were collected 
preoperatively at their preadmission appointment and postoperatively at discharge from the hospital, 
two weeks, six weeks and three months. We used the GAITRite® system to measure gait velocity, stride 
length, single-limb support and single-limb support symmetry. We also had participants complete the 
Timed Up and Go test and a series of questionnaires at each visit: WOMAC, SF-12, Harris Hip Score, and 
pain VAS.

Results: Our primary outcome, gait velocity, was significantly greater in the direct anterior group at 
discharge and six weeks postoperatively with adjusted mean differences of 0.12m/s and 0.17m/s 
respectively. Single-limb support symmetry was also significantly better in the direct anterior group at 
two weeks, six weeks and three months with adjusted mean differences of 0.10, 0.09 and 0.04 
respectively. The direct anterior group also had significantly shorter times to complete the Timed Up 
and Go test at two and six weeks with adjusted mean differences of -9.02s and -2.64s. There were no 
differences between the groups at any time point for the WOMAC, SF-12, Harris Hip Score, or pain VAS.

Conclusion: Preliminary results of our expertise-based study have found the direct anterior approach to 
total hip arthroplasty offers better early functional outcomes than the direct lateral approach.

106 - Natural History of Lateral Femoral Cutaneous Nerve Neuropraxia after Anterior Approach Total 
Hip Arthroplasty: A 5 Year Follow-up 
Paul R Kim, ON; Luca Gala, Italy; Paul E Beaulé, ON

Purpose: The incidence of lateral femoral cutaneous nerve (LFCN) neuropraxia after anterior approach 
total hip arthroplasty has been reported to occur in up to 50% of patients. In the vast majority of cases 
there has been no functional impact it is unknown if symptoms persist or diminish over time. The aim of 
this study was to examine the natural history LFCN neuropraxia in a previously reported cohort of 
individuals after anterior approach total hip arthroplasty.

Method: One hundred and forty three consecutive patients underwent direct anterior hip approach 
(DAA) between September 2006 and February 2009 of which 107 had been identified with LCFN 
neuropraxia. These 107 patients (39 THA; 68 HR; 44 Female & 63 male; mean age 55.4 (38.4-88.8)), were 
provided a self-reported questionnaire for sensory deficits associated with LFCN as well as severity of
symptoms on a 10 point visual analogue scale (VAS). These were done at initial assessment and latest follow-up.

**Results:** Sixty of the 107 patients (56%) completed their questionnaires at a mean follow-up of 5.4 years (24 THA; 36 HR). Twenty-two percent (13 of 60: 8 men & 5 women) had complete resolution of their symptoms (9 HR and 4 THR). Of the 47 patients (78%) still reporting symptoms of LFCN neuropraxia, the mean score on VAS decreased from a mean of 2.32 (SD:2.11) to 1.74 (SD:1.99). No limitation in activities was reported for 90% of patients (54 out of the 60). Of the 6 patients (10%) with limited activity they reported a mean VAS score of 4.4 (SD: 3.6 range of 0-8.4). The LFCN symptoms did not appear to be directly related to their activity limitation.

**Conclusion:** While LFCN neuropraxia can be a common complication following direct anterior approach hip replacement, almost a quarter of patients will have complete resolution of symptoms and the majority will have a decrease in their symptomatology. LFCN neuropraxia following DAA hip arthroplasty does not appear to lead to any functional limitations and is associated with a low score on VAS.

**107 - A Randomized Trial Comparing Ceramic-on-Ceramic Bearing versus Ceramic-on-Crossfire-Polyethylene Bearing Surfaces in Total Hip Arthroplasty**

**D. William C Johnston, AB; Lauren Beaupre, AB; Amro Alhoukail, AB**

**Purpose:** Bearing surfaces in Total Hip Arthroplasty (THA) may affect implant longevity and hence patient outcomes. This randomized clinical trial (RCT) determined how ceramic-on-ceramic bearing (CERAMIC) THA affected joint-specific pain, function and stiffness, and prosthesis fixation/longevity over 10 postoperative years compared with ceramic-on-highly-crosslinked-polyethylene bearing (POLYETHYLENE) THA. This is a follow-up to previously reported five year outcomes.

**Method:** Subjects aged less than 61 years were randomized to CERAMIC [n=48] or POLYETHYLENE [n=44] THA. Subjects were assessed using the Western Ontario McMaster Osteoarthritis Index (WOMAC) and the RAND 12-Item Health Survey (RAND-12) preoperatively, and at one, five and 10 years postoperatively. Plain radiographs were evaluated at 10 years for fixation and medical records were reviewed for revisions.

**Results:** Of 92 subjects, six (7%) died within 10 years; 68 (79%) survivors provided radiographic and/or clinical follow-up at 10 years postoperatively. Improvements seen at five years in both the WOMAC and RAND-12 were retained at 10 years with no group differences (p>0.48). There were no failures/loss of fixation related to bearing surfaces/wear in either group. Over 10 years, three subjects in the POLYETHYLENE group had revisions that were related to recurrent dislocation; two revisions were performed within two years of surgery and one further subject underwent revision at 7 years postoperatively.

**Conclusion:** This is one of the first RCTs to examine 10 year outcomes between ceramic-on-ceramic and ceramic-on-highly-crosslinked-polyethylene bearing THA. Both bearing surfaces performed well out to 10 years in subjects who were less than 61 years at time of surgery.
Purpose: Total Elbow Arthroplasty (TEA) is a procedure to treat a number of conditions including rheumatoid arthritis (RA), post-traumatic arthritis, and osteoarthritis. To date, there has been minimal literature published on the Latitude since its release in 2001. There is one study reporting outcomes from the Latitude, a German study published in 2010. The purpose of this study was to analyze outcomes from primary Latitude TEAs.

Method: We performed a retrospective case series of 23 TEAs performed on 20 patients. 6 patients required revision surgery and were not included in the analysis. One patient was lost to follow up, resulting in 17 patients included for ROM analysis. All patients received Latitude TEA through a posterior approach and underwent a standard rehab protocol. 11 Patients were recalled at least two years post-op and were administered DASH and MAYO questionnaires. Complications such as triceps insufficiency, ulnar nerve dysfunction, infection, and aseptic loosening were recorded. Outcomes were compared using the Wilcoxon Signed-Rank test in STATA. Immediate post-op radiographs and patients most recent radiographs were analyzed by a blinded upper-extremity surgeon not involved in the initial operation and analyzed for loosening and implant malpostioning.

Results: Mean follow up was 4.8 years (range 2.6-7.5 years). Analysis of 17 TEAs in 16 patients revealed no difference in pre-operative ROM and post-operative ROM for flexion (121°±20 vs 129°±16, p=0.13) extension (40°±27 vs 27°±15, p=0.19), pronation (73°±13 vs 75°±24, p=0.55) or supination (64°±22 vs 68°±14, p=0.52). Patients who underwent TEA for RA had a significant improvement in flexion (121°±15 vs 135°±10, p<0.02). There was a statistically significant improvement in flexion-extension arc post-operatively (101°±28) compared to pre-operative scores (83±23 degrees, p<0.02). DASH and MAYO scores were calculated from 11elbows in 11 non-revision patients able to return for examination. The average MAYO score was 87.9 with nine patients in the “excellent” category, two patients in the “good” category, one patient in the “fair” category, and one in the “poor” category. The average DASH score was 32.9. Two patients underwent revision for periprosthetic fractures, two patients underwent revision for infection, one underwent revision for aseptic loosening and two for radial head dissociation (rate of 30%).

Conclusion: This is one of the first studies examining the outcomes of the Latitude TEA. This retrospective case series demonstrates that the Latitude TEA has promising outcomes with respect to improving patient pain and functioning as assessed by the MAYO. Treatment using the Latitude TEA results in favorable functional outcomes for a majority of patients and offers an improvement in flexion-extension arc. Furthermore, our results are comparable to the MAYO scores reported by other studies analyzing different prosthesis designs. The complication rate in our series was comparable to published rates of 20-40%.
A Rapid Detection Method for Propionibacterium Acnes in Surgical Biopsies from the Shoulder

Scott Holmes, ON; Ana Pena Diaz, ON; George S Athwal, ON; Kenneth J. Faber, ON; David B O'Gorman, ON

Purpose: Propionibacterium acnes infection of the shoulder after arthroplasty is a common complication. Current detection methodologies for P. acnes involve prolonged anaerobic cultures that can take up to three weeks before findings can be reported. Our aim was to develop a polymerase chain reaction-restriction fragment length polymorphism (PCR-RFLP) approach that is both sensitive and specific to P. acnes that would enable a 24-hour turnaround between biopsy and results.

Method: Comparisons between the 16S ribosomal sequences of P. acnes and closely related bacteria identified two unique regions in P.acnes to which PCR primers were designed. Additionally, two unique restriction enzyme cut sites for HaeIII were identified within this amplicon. To test the PCR method, arthroscopic surgical biopsies were mechanically homogenized and boiled for 20 minutes to lyse the cellular membranes. PCR was performed using standard conditions followed by a one hour HaeIII enzymatic digest of the PCR product. Resultant fragments were visualized on polyacrylamide gels stained with ethidium bromide. All experiments included no-template controls to rule out reagent contamination and independently confirmed P. acnes DNA as a positive control. Serial dilutions of P. acnes cultures in Robertson’s cooked-meat broth and spectrophotometric analysis of cellular concentration were used to assess the sensitivity of the PCR reaction.

Results: A unique 564 base-pair PCR amplicon was derived from different strains of P. acnes. This amplicon was confirmed as P. acnes DNA by gel excision and DNA sequencing. HaeIII digests of the amplicon yielded 3 restriction fragments at the sizes predicted by in silico analyses. Sensitivity testing confirmed that as few as 10 P. acnes cells in a 50µl reaction volume could be detected using this assay. P. acnes was also detected in surgical biopsy samples.

Conclusion: P. acnes infections following shoulder arthroplasty are a serious complication placing a burden on the healthcare system and the patient due to the lengthy surgical revision process that follows. The infections are also difficult to diagnose. This unique assay combines the sensitivity of PCR with the specificity of RFLP mapping to specifically identify P. acnes in surgical isolates. We anticipate that this assay will allow us to determine if a biopsy is P. acnes positive within 24-hours of sampling, allowing for more aggressive antibiotic therapy and monitoring to avoid implant failure and revision surgery. Additionally, this PCR-RFLP method may decrease the false positive rate of extended length cultures due to P. acnes contamination.

The Rotator Cuff is an Antagonist Following Reverse TSA: A Biomechanical Study of Differing Implant Configurations

G Daniel G Langohr, ON; Joshua W Giles, England; James A Johnson, ON; George S Athwal, ON;

Purpose: Despite reverse total shoulder arthroplasty (RTSA) being primarily indicated for massive rotator cuff tears, it is often possible to repair portions of the infraspinatus and subscapularis of patients undergoing this procedure. However, there is disagreement regarding whether these tissues should be
repaired, as their effects remain unclear. Therefore, we investigated the effects of rotator cuff repair and changes in humeral and glenosphere lateralization (HLat & GLat) on deltoid and joint loading.

**Method:** Six shoulders were tested on an in-vitro muscle driven active motion simulator. Cuff tear arthropathy was simulated in each specimen, which was then implanted with a custom adjustable RTSA fitted with a six axis load sensor. We assessed the effects of 4 RTSA configurations (i.e. all combinations of 0&10mm of HLat & GLat) on deltoid force, joint load, and joint load angle during abduction with/out rotator cuff repair. Deltoid and joint loads recorded by the load cell are reported as a % of Body Weight (%BW). Repeated measures ANOVAs and pairwise comparisons were performed with p<0.05 indicating significance.

**Results:** Cuff repair interacted with HLat & GLat (p=0.005, Fig.1) such that with no HLat, GLat increased deltoid force without cuff repair (8.1±2.1%BW, p=0.012) and this effect was significantly increased with cuff repair (12.8±3.2%BW, p=0.010). However, adding HLat mitigated this such that differences were not significant. HLat and GLat affected deltoid force regardless of cuff status (-2.5±0.7%BW, p=0.016 & +7.7±2.3%BW, p=0.016, respectively). Rotator cuff repair did significantly increase joint load (+11.9±2.1%BW, p=0.002), as did GLat (+13.3±1.5%BW, p<0.001).

**Conclusion:** The increases in deltoid and joint load caused by rotator cuff repair confirm that it acts as an adductor following RTSA and increases deltoid work. Additionally, cuff repair’s negative effects are exacerbated by GLat, which strengthens its adduction affect, while HLat increases the deltoid’s abduction effect thus mitigating the cuff’s antagonistic effects. Cuff repair increases concavity compression within the joint; however, HLat produces a similar effect by wrapping the deltoid around the greater tuberosity – which redirects its force – and does so without increasing the magnitude of muscle and joint loading. The long-term effects of increased joint loading due to rotator cuff repair are unknown, however, it can be postulated that it may increase implant wear, and the risk of deltoid fatigue. Therefore, RTSA implant designs which improve joint compression without increasing muscle and joint loading may be preferable to rotator cuff repair.

**111 - Intermediate Outcomes Following Initial Treatment of Proximal Humerus Fractures in Ontario, Canada: A Population Based, Retrospective Cohort**

**Lauren L Nowak, ON; Milena Vicente, ON; Marissa Bonyun, ON; Aaron Nauth, ON; Michael D McKee, ON; Emil H Schemitsch, ON**

**Purpose:** Proximal humerus fractures are a common fragility fracture in older adults. A variety of treatment options exist, yet longer term outcomes of newer surgical treatments have not been extensively researched. Additionally, intermediate term outcomes following both surgical and non-surgical initial treatment of these injuries have not been evaluated at a population level. The purpose of this study was to utilize administrative data from Ontario, Canada to evaluate intermediate term outcomes following initial treatment of proximal humerus fractures.

**Method:** We used data from the Canadian Institute for Health Information to identify all patients aged 50 and older who presented to an ambulatory care facility with a “main diagnosis” of proximal humerus fracture from April 1, 2004 to March 31, 2013. Intervention codes from the Discharge Abstract Database
were used to categorize patients into fixation, replacement, reduction or non-surgically treated groups. We used intervention codes to identify instances of complication-related operations following initial treatment (including fixation, replacement, hardware removal, rotator cuff repair and irrigation and debridement [I&D]) at one year post initial treatment.

**Results:** The majority of patients (28,369, 86.6%, 95% confidence interval [95% CI] 86.2-87.0%) were initially treated non-surgically, while 2835 (8.7%, 95% CI 8.4-9.0%) underwent initial fixation, 1280 (3.9%, 95% CI 3.7-4.1%) received primary joint replacement, and 276 (0.8%, 95% CI 0.8-1.0%) were initially treated with a reduction procedure. In the year following the initial treatment period, 127 (0.4%, 95%CI 0.4-0.5%) non-surgically treated patients underwent a replacement surgery, 292 (1.0%, 95% CI 0.9-1.2%) underwent fixation, and 12 (0.04%, 95% CI 0.02-0.07%) underwent a reduction procedure. Of the 2835 patients who received initial fixation, 57 (2.0%, 95% CI 1.6-2.6%) returned for a shoulder replacement, 80 received secondary fixation (2.8%, 95% CI 2.3-3.5%), 57 (2.0%, 95% CI 1.6-2.6%) underwent rotator cuff repair, 300 (10.6%, 95% CI 9.5-11.8%) had their implants removed, and 16 (0.6%, 95% CI 0.4-0.9%) returned for I&D. Of the 1280 patients who underwent initial replacement surgeries, 30 (2.3%, 95% CI 1.7-3.3%) returned for a secondary replacement, nine (0.7%, 95% CI 0.4-1.3%) underwent rotator cuff repair, and seven (0.6%, 95% CI 0.3-1.1%) had their implant removed. In the group who received initial reduction, eight (2.9%, 95% CI 1.5-5.6%) underwent a fixation procedure, six (2.2%, 95% CI 1.0-4.7%) received replacement surgeries, and five (1.8%, 95% CI 0.8-4.2%) each received rotator cuff repair and I&D in the year following initial treatment.

**Conclusion:** The majority of proximal humerus fractures in patients 50 and older in Ontario, Canada are treated non-surgically. Complication-related operations in the year following initial non-operative treatment are relatively low. The most commonly observed procedure following initial fixation surgery is hardware removal.

**112 - A Cost-effectiveness Analysis of Reverse Total Shoulder Arthroplasty versus Hemiarthroplasty for the Management of Complex Proximal Humeral Fractures in the Elderly**

**Gerard P Slobogean, US; Georg Osterhoff, BC; Nathan O'Hara, BC; Jennifer D'Cruz, ON; Sheila Sprague, ON; Nick Bansback, BC; Nathan Evaniew, ON**

**Purpose:** There is ongoing debate regarding the optimal surgical treatment of complex proximal humeral fractures in elderly patients. The aim of this study was to evaluate the cost-effectiveness of reverse total shoulder arthroplasty (RTSA) compared to hemiarthroplasty (HA) in the management of these fractures.

**Method:** A cost–utility analysis using decision tree and Markov modelling based on data from the published literature was conducted. A single-payer perspective with a lifetime time horizon was adopted. A willingness to pay threshold of CAD $50,000 was used. The incremental cost-effectiveness ratio (ICER) was used as the study’s primary outcome measure.

**Results:** In comparison to HA, the incremental cost per QALY gained for RTSA was $13,679. One-way sensitivity analysis revealed the model to be sensitive to the RTSA implant cost and the RTSA procedural costs. Two-way sensitivity analysis suggested RTSA could also be cost-effective within the first two years.
of surgery with an early complication rate as high as 25% (if RTSA implant cost was approximately $3,000); or conversely, RTSA implant cost could be as high as $8,500 if its early complication rates were 5%. The ICER of $13,679 is well below the WTP threshold of $50,000 and probabilistic sensitivity analysis demonstrated that 92.6% of model simulations favoured RTSA.

Conclusion: Our economic analysis found that RTSA for the treatment of complex proximal humeral fractures in the elderly is the preferred economic strategy when compared to HA. The ICER of RTSA is well-below standard willingness to pay thresholds, and its estimate of cost-effectiveness is similar to other highly successful orthopaedic strategies such as total hip arthroplasty for the treatment of hip arthritis.

113 - Reverse Total Shoulder Arthroplasty for the Treatment of Osteoarthritis without Rotator Cuff Tear

Purpose: Patients over 70 years old have subclinical or impending rotator cuff dysfunction, raising concern about TSA in this population. The purpose of this study is to examine whether reverse total shoulder arthroplasty (RTSA) should be considered for the treatment of glenohumeral osteoarthritis in the presence of an intact rotator cuff (GHOA+IRC in patients older than 70 years of age.

Method: Twenty-five elderly (>70 years) patients at least one year status-post RTSA for GHOA+IRC were matched via age, sex, body mass index, smoking status, and whether the procedure involved the dominant extremity with 25 GHOA+IRC patients who received anatomic total shoulder arthroplasty (TSA). Standardized outcome measures, range of motion, and treatment costs were compared between the two groups. Treatment cost was assessed using implant and physical therapy costs as well as reimbursement.

Results: Patients who received RTSA for GHOA+IRC had significantly lower pre-operative active forward elevation (AFE, 69° vs. 98°, p <0.001) and experienced a greater change in AFE (p=0.01), but had equivalent AFE at final follow-up (140° vs. 142°, p=0.71). Outcomes were otherwise equivalent between groups with no differences. In both those patients who underwent TSA and those that underwent RTSA, significant improvements between pre-operative and final follow-up were seen in all standardized outcome measures and in AFE (p<0.001 in all cases). RTSA provided these outcomes at a cost savings of $2,025 in Medicare reimbursement due to decreased physical therapy costs.

Conclusion: In patients over the age of 70 with GHOA+IRC, RTSA provides similar improvement in clinical outcomes to TSA at a reduced cost while avoiding issues related to the potential for subclinical or impending rotator cuff dysfunction.

114 - Comparison of Humeral Head Osteotomy using Anatomic and Guide-assisted Cuts
Emily Anne West, ON; Nikolas Knowles, ON; Louis Ferreira, ON; George Athwal, ON

Purpose: Shoulder arthroplasty is used to treat osteoarthritis, post-traumatic arthritis, and avascular necrosis. Modular components allow for natural variability in shoulder anatomy, including retroversion
and head-neck angles. Surgical options include anatomic or guide-assisted cut at a fixed retroversion and head-neck angle. The purpose of this study was to determine the variability between head height (HH) and anteroposterior (AP) and superoinferior (SI) diameters using anatomic and guide-assisted humeral head cuts.

**Method:**Computed tomography scans of 10 cadaveric shoulder specimens (5 male, 5 female) were converted to 3D models. An anatomic humeral head cut plane was placed at the anatomic head–neck junction maintaining the posterior cuff insertion for all shoulders by a fellowship trained shoulder surgeon. Cut planes were generated for standard implant head neck angles (125°,130°,135°, and 140°) and retroversion angles (20°,30°, and 40°) in commercial cutting guides, for a combination of 12 repeated cut conditions per specimen. The humeral HH and the head diameter were measured in the AP and the SI planes for anatomic and guide-assisted osteotomy planes. Differences were compared using a separate two-way repeated measures ANOVA for each dependent variable.

**Results:**Guide-assisted cuts showed no significant effect on HH due to head-neck (p=0.205) or retroversion angles (p=0.190). These results persisted by gender (male: head-neck p=0.659 and retroversion p=0.386; female: head-neck p=0.204 and retroversion p=0.190). SI diameter increased by 1.3 mm with increasing head-neck angle (p<0.001), but there was no effect due to retroversion (p=0.148). A head-neck angle of 125° caused the greatest decrease in SI diameter of -2.8 mm compared to the anatomic cut, averaged over the retroversion range. The greatest reduction of SI diameter, -3.4 mm compared to anatomic, occurred with 125° head-neck angle and 20° retroversion. By gender, males showed a significant effect from head-neck angle (p=0.008), but females did not (p=0.077). There was no significant difference from retroversion in either gender group (male p=0.792; female p=0.057). There was no significant difference in AP diameter by head-neck (p=0.192) or retroversion angles (p=0.168). These results persisted in the males (head-neck p=0.420 and retroversion p=0.780). In females, there was no effect from head-neck angle (p=0.232); however, retroversion angle trended toward significance (p=0.050).

**Conclusion:**For patients whose natural anatomy falls outside the range of the commercial cut guides, templated resection may result in deviation from natural humeral head dimensions. Due to the large variability in anatomic retroversion and head-neck angles in the subjects of this study, further study with a larger sample size is needed to investigate observed trends. These preliminary results have implications for manufacturers to create guides to represent a larger segment of the population, and surgeons’ intra-operative choice.

115 - An Anatomical Study of the Trabecular Bone Density Distribution in the Scapula Relevant to Reverse Shoulder Arthroplasty Glenoid Baseplate Fixation
Matt Daalder, ON; Gabriel Venne, ON; Michael Rainbow, ON; Timothy Bryant, ON; Ryan T. Bicknell, ON

**Purpose:**While reverse shoulder arthroplasty (RSA) is a reliable treatment option for patients with rotator cuff deficiency, loss of glenoid baseplate fixation often occurs due to screw loosening. We questioned whether an analysis of the trabecular bone density distribution in the scapula would indicate more optimal sites for screw placement. As such, the purpose of this study was to determine the
anatomic distribution of trabecular bone density in regions of the scapula available for screw placement in RSA.

Method: Seven cadaveric shoulders were computed tomography (CT) scanned, and then voxels of the scapulae were isolated from the CT volume (Mimics 15.0 Materialise, Leuven, Belgium). Analyses were conducted in a common, 3D coordinate system. Volumetric regions of interest (ROI) within the scapula were identified based on potential baseplate screw sites. ROIs included areas at the base of the coracoid process lateral and inferior to the suprascapular notch, in the posterior and anterior lateral spine and in the anterosuperior and posteroinferior lateral border. Hounsfield Units (HU) were extracted from voxels corresponding to trabecular bone within each ROI. Overall bone density was summarized as the frequency of HU values above 80% of the ROI’s maximum density value. Paired, two-tailed t-tests assuming unequal variance were used for pairwise comparisons (P≤0.05). Intra-region analyses compared two ROIs within the same broad anatomical structure; inter-region analyses compared ROIs between anatomical structures.

Results: Areas of the spine and lateral border of the scapula appeared to be denser than the coracoid process. Intra-region comparisons indicated no significant differences within ROI: coracoid P=0.43, spine P=0.95, lateral border P=0.41. ROI inferior to the suprascapular notch were on average 3.78% (P=0.08) and 6% (P=0.04) less dense than the anterosuperior and posteroinferior lateral border and 7.59% (P=0.006) and 7.72% (P=0.01) less dense than the anterior and posterior lateral spine. ROI lateral to the suprascapular notch were 6% (P=0.05) and 8.21% (P=0.02) less dense than the anterosuperior and posteroinferior lateral border and 9.8% (P=0.006) and 9.94% (P=0.008) less dense than the anterior and posterior lateral spine. There was no significant difference between the anterior spine and anterosuperior and posteroinferior lateral border (P=0.12, P=0.58), nor between the posterior spine and anterosuperior and posteroinferior lateral border (P=0.14, P=0.57).

Conclusion: Results from this study indicate that the spine and lateral border of the scapula contain denser trabecular bone relative to regions in the coracoid. The higher quality bone of the spine and lateral border should be favoured over the coracoid process when fixing the glenoid baseplate in RSA. Further research may support the redesign of the glenoid baseplate geometry to better integrate the anatomy of the scapula and improve implant survival.

116 - Two Year Results of a Prospective Study on the Natural History of Non-operatively Treated Type III Acromioclavicular Joint Dislocations

Danielle Stachiw, NWT; Alex Malone, England; Andrew Strang, England; Andrew Matthews, England

Purpose: We present 2 year results of a prospective natural history study of Type III Acromioclavicular joint dislocation (ACJD) treated non-operatively. Previous natural history studies are compromised by inconsistent definitions of the grade of injury and non-validated scoring tools; they do not identify which patients will have ongoing symptoms. This trial documents the strength and subjective recovery over time, and identifies risk factors for poor outcome and need for surgery.

Method: Patients with Rockwood Type III ACJD received a standardized rehabilitation protocol (6 sessions of physiotherapy). Clinical assessment was performed at presentation, 3, 6, 12 and 24 months
after injury, including isometric strength testing, pain (VAS/10) and subjective scores -Subjective percentage of normal (SPON), American Shoulder and Elbow (ASES), Oxford Shoulder Score (OSS) and Quick Disabilities of Arm Shoulder and Hand (qDASH).

Results: 28 male patients were recruited, 26 reached 12, and 9 to 24 months follow up. Two required surgery and one emigrated. The mean age was 39 (15 to 67). Initial mean pain was 3/10, SPON 51% (6-95) and strength was 76% of the other side. By 3 months mean subjective recovery was 70% and strength 90%. Strength recovered to 99% of normal by 12 months but subjective scores remained at mean 90%; by 24 months subjective scores were mean 94%. 2 patients had subjective scores <80%.

Conclusion: There was a wide range of initial subjective scores and weakness after Type III ACJD. 95% of strength had recovered by 6 months and subjective scores recovered to 94% of normal by 24 months. 4 patients (14%) did poorly with 2 requiring surgery. Low initial subjective score and inability to abduct the arm at presentation were risk factors for a poor outcome.

117 - Massive Irreparable Rotator Cuff Tears Without Arthropathy: The Role of the Balloon (Biodegradable Spacer) and Comparison to Other Operative Treatments
Leslie Naggar, Switzerland

Purpose: Massive irreparable rotator cuff tears (MIRCTs) represent a difficult situation especially in painful and pseudoparalytic patients. A new technique, consisting of an arthroscopic implantation of an inflatable biodegradable "balloon", serving as a temporary subacromial spacer, has been introduced recently for MIRCTs. The purpose of this paper is: 1) to present the efficacy and safety results of patients treated with the balloon; 2) to show that these results are maintained over time, after balloon degradation; 3) to compare these results to published results of other procedures available for MIRCTs.

Method: This paper presents the first group of 22 patients (females/males 13/8, one bilateral), treated in a single-surgeon, prospective and on-going series of 97 shoulders operated with the balloon, since September 2010. The mean age is 69.3 (52-86) and the average follow-up 52.5 months. The balloon is inserted arthroscopically and inflated with saline. The procedure is simple with a short operative time (10-20 min). It can also supplement partial repairs, especially of the subscapularis, as well as repairable massive tears with bad tissue quality. The balloon is not used in severe cuff tear arthropathy or complete insufficiency of the external rotators. Final outcome scores, Constant (CS) and UCLA scores are obtained at least three years after complete balloon degradation (which occurs within 12 months), and are also compared to those of other treatments available for MIRCTs.

Results: No device related safety issues were observed in this group. Good results, including rapid pain relief and restoration of active motion, which maintained over time, are obtained in 85% of the patients. The CS has improved significantly (average preop/postop: pain 2.9/12.7; ADL 6.8/17.4; ROM 22.8/36.6; strength 3.1/5.6; TOTAL 35.8/72.3; NORMATIVE 42.7/86.4). The UCLA score has also improved significantly (preop/postop: pain 1.9/8.6; function 3.9/8.6; active flexion 3.5/4.5; strength in flexion 2.4/3.4; satisfaction 0/4.5; TOTAL 11.2/29.8). Pseudoparalysis is reversed (average preop/postop flexion 86°/156.8°). The CS and UCLA score for the balloon are superior compared to published results of debridement, biceps tenotomy/tenodesis, partial repair, tuberoplasty and latissimus dorsi transfer. CS
(86.4/63.8), CS pain (12.7/11.9) and flexion (156.8/128.0) are also better for the balloon compared to the reverse prosthesis.

**Conclusion:** The balloon is indicated for MIRCTs, as well as reparable massive tears with a high risk of retear. The implantation is a straightforward and short procedure, which has excellent safety profile and positive effect on painful MIRCTs including pseudoparalysis. The balloon provides significant improvement in the CS and UCLA score that persists way beyond its degradation. The balloon patients' shoulder function is superior to the other available treatment options. Additional studies are needed to further confirm the effectiveness of the balloon as a first line treatment for MIRCTs.
118 - Effectiveness of a Posterior Shoulder Stretching Program on Collegiate-level Overhead Athletes: A Randomized Controlled Trial
David M Sheps, AB; Judy Chepeha, AB; David Magee, AB; Lauren Beaupre, AB

Purpose: Athletes involved in repetitive overhead shoulder rotation demonstrate increased external rotation and decreased internal rotation range of motion. Deficits in internal rotation have been linked to the development of shoulder pathology. The purpose of this study is to determine if a posterior shoulder stretch program is effective in increasing dominant arm internal rotation and horizontal adduction range of motion in overhead athletes identified as having reduced mobility and posterior shoulder tightness.

Method: Thirty-seven overhead athletes in volleyball, swimming and tennis, with internal rotation range of motion deficits greater than or equal to 15°, were randomized into intervention or control groups. The intervention group performed the “sleeper stretch” daily for eight weeks while the control group performed usual activities. Independent t-tests determined whether internal rotation and horizontal adduction range of motion differences between groups were significant and two-way repeated measures analysis of variance tests measured the rate of shoulder range of motion change. Reported shoulder pain and function were also obtained at each evaluation.

Results: Significant differences were found between the intervention and control groups’ internal rotation and horizontal adduction range of motion at eight weeks (p<0.001 and p=0.003 respectively) compared to baseline (zero weeks) (p=0.19 and p=0.82 respectively). Significant changes in internal rotation were detected in the intervention group at four weeks (p<0.001) with further adaptations noted at eight weeks. Horizontal adduction improved at a slower rate demonstrating significant changes at eight weeks (p=0.003). Reported shoulder pain and functional ability (p=0.002) were different between the study groups at eight weeks.

Conclusion: Overhead, collegiate-level athletes with an internal rotation deficit greater than or equal to 15° are able to significantly increase internal rotation and horizontal adduction range of motion by performing a posterior shoulder stretch exercise for eight weeks.

119 - Engaging Hill-Sachs Defects: Diagnosis in Cadaveric Shoulders
David Burns, ON; Jaskarndip Chahal, ON; Shahram Shahrokhi, ON; Patrick Henry, ON; David Wasserstein, ON; Cari Whyne, ON; John Theodoropoulos, ON; Darrell Ogilvie-Harris, ON; Tim Dwyer, ON

Purpose: Anatomic studies have demonstrated that bipolar glenoid and humeral bone loss have a cumulative impact on shoulder instability, and that these defects may engage in functional positions depending on their size, location, and orientation, potentially resulting in failure of stabilization procedures. Determining which lesions pose a risk for engagement remains a challenge, with Itoi’s 3DCT based glenoid track method and arthroscopic assessment being the accepted approaches at this time. The purpose of this study was to investigate the interaction of humeral and glenoid bone defects on shoulder engagement in a cadaveric model. Two alternative approaches to predicting engagement were
evaluated; 1) CT scanning the shoulder in abduction and external rotation 2) measurement of Bankart lesion width and a novel parameter, the intact anterior articular angle (IAAA), on conventional 2D multi-plane reformats.

**Method:** Hill-Sachs and Bony Bankart defects of varying size were created in 12 cadaveric upper limbs, producing 45 bipolar defect combinations. The shoulders were assessed for engagement using cone beam CT in various positions of function, from 30 to 90 degrees of both abduction and external rotation. The humeral and glenoid defects were characterized by measurement of their size, location, and orientation. The abduction external rotation scan and 2D IAAA approaches were compared to the glenoid track method for predicting engagement.

**Results:** Engagement was predicted by Itoi's glenoid track method in 24 of 45 specimens (53%). The abduction external rotation CT scan performed at 60 degrees of glenohumeral abduction (corresponding to 90 degrees of abduction relative to the trunk) and 90 degrees of external rotation predicted engagement accurately in 43 of 45 specimens (96%), with sensitivity and specificity of 92% and 100% respectively. A logistic model based on Bankart width and IAAA provided a prediction accuracy of 89% with sensitivity and specificity of 91% and 87%. Inter-rater agreement was excellent (Kappa = 1) for classification of engagement on the abduction external rotation CT, and good (intraclass correlation = 0.73) for measurement of IAAA.

**Conclusion:** Bipolar lesions at risk for engagement can be identified using an abduction external rotation CT scan at 60 degrees of glenohumeral abduction and 90 degrees of external rotation, or by performing 2D measurements of Bankart width and IAAA on conventional CT multi-plane reformats. This information will be useful for peri-operative decision making around surgical techniques for shoulder stabilization in the setting of bipolar bone defects.

**120 - Assessment of Intraoperative Intra-articular Morphine and Clonidine Injection following Hip Arthroscopy on Postoperative Pain Management**

**Vehniah Tjong,** US; Charles Cogan, US; Michael Knesek, US; Reuben Nair, US; Cynthia Kahlenberg, US; Michael A Terry, US

**Purpose:** Previous authors have suggested that the analgesic effects of intra-articular morphine may be beneficial. Clonidine has been found to potentiate the analgesic effect of morphine. Following knee arthroscopy, morphine has demonstrated equivocal effect in comparison to bupivacaine for analgesia while circumventing the issue of chondrotoxicity. There have been no studies evaluating the effect of intra-articular morphine following hip arthroscopy. The purpose of this study was to evaluate the efficacy of intra-articular morphine in combination with clonidine on pain and narcotic consumption following hip arthroscopy surgery for femoroacetabular impingement.

**Method:** A retrospective review was performed on 43 patients that underwent hip arthroscopy between September 2014 and May 2015 at our institution for femoroacetabular impingement. All patients received preoperative Celebrex and Tylenol per our anesthesia protocol, and 22 patients received an additional intra-articular injection of 10 mg morphine and 100 mcg of clonidine at the
conclusion of the procedure. Narcotic consumption, duration of anesthesia recovery, and perioperative pain scores were compared between the two groups.

**Results:** We found that patients who received intra-articular morphine and clonidine used significantly less opioid analgesic in the PACU, with 23 mEq of morphine equivalents required in the intra-articular morphine and clonidine group compared to 40 mEq of opioid equivalents in the non-injection group (p=0.0259). There were no statistically significant differences in time spent in recovery prior to discharge or in VAS pain scores recorded immediately post-operatively and at one hour following surgery.

**Conclusion:** In conclusion, we found that an intraoperative intra-articular injection of morphine and clonidine significantly reduced the amount of narcotic requirement following hip arthroscopy. We do believe that there may be significant benefits to this, including less systemic effects from overall narcotic usage in the perioperative period. Our study demonstrated a beneficial effect of intra-articular morphine that may help with overall pain improvement, less narcotic consumption, and improved patient satisfaction following outpatient hip arthroscopy. This study provides the foundation for future research currently being conducted in a randomized-control setting.

121 - Outcomes following Arthroscopic Treatment of Femoroacetabular Impingement for Patients with Borderline Hip Dysplasia


**Purpose:** The outcomes of hip arthroscopy in the treatment of dysplasia are variable. Historically, arthroscopic treatment of severe dysplasia (lateral center-edge angle [LCEA] < 18°) resulted in poor outcomes and iatrogenic instability. However, in milder forms of dysplasia, favorable outcomes have been reported. The purpose of this study was to compare outcomes following hip arthroscopy for femoracetabular impingement (FAI) in borderline dysplastic (BD) patients compared with a control group of non-dysplastic patients.

**Method:** Between March 2009 and July 2012, a BD group (LCEA 18°-25°) of 46 patients (55 hips) was identified. An age and sex-matched control group of 131 patients (152 hips) was also identified (LCEA 25°-40°). Patient-reported outcome scores, including the Modified Harris Hip Score (mHHS), the Hip Outcome Score-Activity of Daily Living (HOS-ADL), the Sport-specific Subscale (HOS-SSS), and the International Hip Outcome Tool (iHOT-33), were collected pre-operatively, at 1, and 2 years.

**Results:** The mean LCEA was 22.4 ± 2.0° (range, 18.4°-24.9°) in the BD group and 31.0 ± 3.1° (range, 25.4°-38.7°) in the control group (p<0.001). The mean preoperative alpha angle was 66.3 ± 9.9° in the BD group and 61.7 ± 13.0° in the control group (p=0.151). Cam decompression was performed in 98.2% and 99.3% of cases in the BD and control groups. Labral repair was performed in 69.1% and 75.3% of the BD and control groups respectively, with 100% of patients having a complete capsular closure performed in both groups. At a mean follow-up of 31.3 ± 7.6 months (range, 23.1-67.3) in unrevised patients and 21.6 ± 13.3 months (range 4.7-40.6) in revised patients, there was significant improvement (p<0.001) in all patient reported outcome scores in both groups. Multiple regression analysis did not identify any significant differences between groups. Importantly, female sex did not appear to be a predictor for
inferior outcomes. Two patients (4.3%) in the BD group and six patients (4.6%) in the control group required revision arthroscopy during the study period.

**Conclusion:** Favorable outcomes can be expected following the treatment of impingement in borderline dysplastics when labral refixation and capsular closure are performed, with comparable outcomes to non-dysplastic patients. Further follow-up in larger cohorts is necessary to prove the durability and safety of hip arthroscopy in this challenging group and to further explore potential gender-related differences in outcome.

122 - Clinical Outcomes of Hip Arthroscopy: A Prospective Analysis of a Large Mixed Cohort
Parth Lodhia, BC; Chengcheng Gui, US; Sivashankar Chandrasekaran, BC; Carlos Suarez-Ahedo, Mexico; Benjamin G Domb, US

Comments: We present a prospective two-year follow-up study of 1038 hip arthroscopies performed at a high volume tertiary referral center for hip preservation. We feel that this manuscript is both pertinent and timely due to the advances in the field of hip preservation.

We used four validated patient-reported outcome (PRO) scores along with the visual analog scale (VAS) and patient satisfaction scores to assess preoperative and postoperative outcomes in all patients undergoing hip arthroscopy. We divided the entire cohort into patients undergoing primary and revision hip arthroscopies. We found a statistically significant improvement from preoperative to two-year postoperative PRO scores in the two subgroups. We also found a significant difference in the PRO scores at three months, one year, and two years postoperatively between the primary and revision subgroups. The revision subgroup had inferior VAS and patient satisfaction compared to the primary subgroup, however these results were not significant. The conversion to total hip arthroplasty/hip resurfacing (THA/HR) was 5.6% and 11.2% in the primary and revision subgroups, respectively. This resulted in a relative risk of 2.0 for conversion to THA/HR in the revision subgroup. We had a complication rate of 5.3 (only 0.5% of which were considered major) which was similar to that reported in the literature for hip arthroscopy.

**Purpose:** The primary purpose was to perform a survival analysis in a large mixed cohort of patients undergoing hip arthroscopy at a high volume tertiary referral center for hip preservation with minimum two-year follow-up. The secondary purpose was to compare clinical outcomes of primary versus revision hip arthroscopy.

**Method:** From February 2008 to June 2012, data were prospectively collected on all patients undergoing primary or revision hip arthroscopy. Patients were assessed pre- and post-operatively with modified Harris Hip Score (mHHS), Non-Arthritic Hip Score (NAHS), Hip Outcome Score-Activities of Daily Living (HOS-ADL), and Hip Outcome Score-Sport Specific Subscales (HOS-SSS). Pain was estimated on the visual analog scale (VAS). Patient satisfaction was measured on a scale from 0 to 10.

**Results:** There were a total of 1155 arthroscopies performed, including 1040 primary arthroscopies (926 patients) and 115 revision arthroscopies (106 patients). Of these, 931 primary arthroscopies (89.5%) in 824 patients (89.0%) and 107 revision arthroscopies (93.0%) in 97 patients (91.5%), were available for
follow-up and included in our study. The mean change in patient reported outcome (PRO) scores at two-year follow-up in the primary subgroup was 17.4 for mHHS, 19.7 for HOS-ADL, 23.8 for HOS-SSS, 21.3 for NAHS, and -3.0 for VAS. The mean change in PRO scores at two-year follow-up in the revision subgroup was 13.4, 10.9, 16.1, 15.4, and -2.7, respectively. All scores improved significantly compared to preoperatively (p<0.001). PRO scores were higher at all time points for the primary subgroup compared to the revision subgroup (p<0.05). Satisfaction was 7.7 and 7.2 for primary and revision subgroups, respectively. Of 931 primary arthroscopies, 52 (5.6%) underwent THA/HR. Of 107 revision arthroscopies, 12 (11.2%) underwent THA/HR. The relative risk of a THA/HR was 2.0 after revision procedures compared to primary procedures. The overall complication rate was 5.3%.

**Conclusion:** Hip arthroscopy showed significant improvement in all PRO, VAS, and satisfaction scores at two years postoperatively. Primary arthroscopy patients showed greater PRO scores and a trend towards greater VAS compared to the revision subgroup. The relative risk of a THA/HR was 2.0 after revision procedures compared to primary procedures.

**123 - The Direct Environmental Impact of Hip Arthroscopy for Femoroacetabular Impingement (FAI): A Surgical Waste Audit**  
**Olufemi R Ayeni, ON; Darren de SA, ON; Kellee Stephens, ON; Michelle Kuang, ON; Nicole Simunovic, ON; Jon Karlsson, Sweden**

**Purpose:** Health care facilities are major contributors of waste to landfills, with operating rooms estimated to assume 20-70% of this waste. With hip arthroscopy for femoroacetabular impingement (FAI) on the rise, it is important to understand its environmental impact and identify areas for greening practices. Given its minimally-invasive nature, we hypothesize overall arthroscopic waste per FAI patient case to be approximately 5 kg, with minimal biohazard waste. The purpose of this study was to determine the amount of waste produced in FAI procedures and understand the environmental impact of the procedure to aid us in developing greening practices.

**Method:** A single surgeon waste audit (with descriptive statistics) of five FAI hip arthroscopy procedures – categorized by: 1) normal/landfill waste; 2) recyclable cardboards and plastics; 3) biohazard waste; 4) sharp items; 5) linens; and 6) sterile wrapping - was performed in April 2015.

**Results:** The surgical waste (except laundered linens) from the five FAI surgeries totalled 47.4 kg, of which 21.7 kg (45.7%) was biohazard waste, 11.7 kg (24.6%) was sterile wrap, 6.4 kg (13.5%) was normal/landfill waste, 6.4 kg (13.5%) was recyclable plastics, and 1.2 kg (2.6%) was sharp items. There was an average of 9.4 kg (excluding laundered linens) of waste produced per procedure.

**Conclusion:** Considerable waste, specifically biohazard waste, is produced in FAI procedures with an average of 9.4 kg of waste produced per procedure, including 4.3 kg of biohazard waste. In Canada (population 35.7 million), approximately 18 800 kg of waste (8600 kg of biohazard waste) is produced from an estimated 2000 FAI procedures performed every year. Additional recycling programs, reducing surgical overage, and continued adherence to proper waste segregation will be helpful in reducing waste production and its environmental burden. An emphasis on “green outcomes” is also required to demonstrate environmental responsibility and effectively manage and allocate finite resources.
124 - Arthroscopic Treatment for Shoulder Instability with Glenoid Bone Loss Using Distal Tibia Allograft Augmentation - Short Term Results

Eyal Amar, NS; Daryl B Dillman, NS; Benjamin Smith, ON; Catherine M Coady, NS; Ivan H Wong, NS

Purpose: Background: The results of arthroscopic anterior labral (Bankart) repair have been shown to have high failure rate in patients with significant glenoid bone loss. Several reconstruction procedures using bone graft have been described to overcome the bone loss, including autogenous coracoid transfer to the anterior glenoid (Latarjet procedure) as well as iliac crest autograft and tibial allografts. In recent years, trends toward minimally invasive shoulder surgery along with improvements in technology and technique have led surgeons to expand the application of arthroscopic treatment. Purpose: This study aims to perform a retrospective analysis of prospectively collected data to evaluate the clinical and radiological follow up of patient who underwent anatomic glenoid reconstruction using distal tibia allograft for the treatment of shoulder instability with glenoid bone loss at 1-year post operation time point.

Method: Between December 2011 and January 2015, 55 patients underwent arthroscopic stabilization of the shoulder by means of capsule-labral reattachment to glenoid ream and bony augmentation of glenoid bone loss with distal tibial allograft for recurrent instability of the shoulder. Preoperative and postoperative evaluation included general assessment by the western Ontario shoulder instability index (WOSI) questionnaire, preoperative and postoperative radiographs and CT scans.

Results: Fifty-five patients have been evaluated with mean age of 29.73 years at time of the index operation. There were 40 males (mean age of 29.66) and 15 female (mean age of 29.93). Minimum follow up time was 12 months. The following adverse effects were recorded: none suffered from recurrent dislocation, 2 patients suffered from bone resorption but without overt instability, 1 patient had malunion due to screw fracture, None of the patients had nonunion. The mean pre-operative WOSI score was 36.54 and the mean postoperative WOSI score was 61.0.

Conclusion: Arthroscopic stabilization of the shoulder with distal tibia allograft augmentation demonstrates promising result at 1-year follow up.

125 - Femoroacetabular Impingement: Have We Hit a Global Tipping Point in Diagnosis and Treatment? Results from the InterNational Femoroacetabular Impingement Optimal Care Update Survey (IN FOCUS)

Mohit Bhandari, ON; Moin Khan, ON; Olufemi Ayeni, ON; Kim Madden, ON; Asheesh Bedi, US; Anil Ranawat, US; Bryan Kelly, US; Parag Sancheti, India; Leandro Ejnisman, Brazil; Eleftherios Tsiridis, Greece

Purpose: Femoroacetabular impingement (FAI) is a common cause of hip pain in the young adult. Uncertainty regarding surgical indications, outcome assessment, management preferences and perceptions of the literature exist. We conducted a large international survey assessing the perceptions and demographics of orthopaedic surgeons regarding FAI.

Method: A survey was developed using previous literature, focus groups and a sample-to-redundancy strategy. The survey contained forty-six questions and was emailed to national orthopaedic associations.
and orthopaedic sports medicine societies for member responses. Members were contacted on multiple occasions to increase response rates.

**Results:** Nine hundred orthopaedic surgeons from twenty national and international organizations completed the survey. Surgeons responded across 6 continents, 58.2 % from developed nations with 35.4 % having sports fellowship training. North American and European surgeons reported significantly greater exposure to hip arthroscopy during residency and fellowships in comparison to international respondents (48.0% vs. 44.5% vs. 25.6% respectively; p<0.001). Surgeons performing a higher volume of FAI surgery (over 100 cases per year) were significantly more likely to have practiced for more than 20 years (OR 1.91; 95% CI 1.01 to 3.63), be practicing at an academic hospital (OR 2.25; 95% CI 1.22 to 4.15), and have formal arthroscopy training (OR 46.17; 95% CI 20.28 to 105.15). High volume surgeons were over two-fold more likely to practice in North America and Europe (OR 2.26; 95% CI: 1.08 to 4.72).

**Conclusion:** The exponential rise in the diagnosis and surgical management for FAI appears to be driven largely by experienced surgeons in developed nations. Our analysis suggests that although FAI management is early in the innovation cycle we are at a tipping point towards wider uptake and utilization. The results of this survey will help guide further research and study.

**126 - Biomechanical Comparison of Acute Hill-Sachs Reduction and Remplissage to Treat Complex Anterior Instability: The Potential Benefits of Anatomic Reconstruction**


**Purpose:** Acute Hill-Sachs (HS) reduction represents a potential alternative method to remplissage for the treatment of an engaging HS lesion. The purpose of this study is to biomechanically compare the stabilizing effects of a acute HS reduction technique and remplissage in a complex instability model.

**Method:** This was a comparative cadaveric study of 6 shoulders. For the acute HS lesion, a unique model was used to create a 30% defect, compressing the subchondral bone while preserving the articular surface in a more anatomic fashion. In addition, a 15% glenoid defect was made in all specimens. The HS lesion was reduced through a lateral cortical window with a bone tamp, and the subchondral void was filled with Quickset (Arthrex) bone cement to prevent plastic deformation. Five scenarios were tested; intact specimen, bipolar lesion, Bankart repair, remplissage with Bankart repair and HS reduction technique with Bankart repair. Translation, kinematics and dislocation events were recorded.

**Results:** For all 6 specimens no dislocations occurred after either remplissage or the reduction technique. At 90 degrees of abduction and external rotation (ABER), anterior-inferior translation was 11.1 mm (SD 0.9) for the bipolar lesion. This was significantly reduced following both remplissage (5.1±0.7mm; p<0.001) and HS reduction (4.4±0.3mm; p<0.001). For anterior-inferior translation there was no significant difference in translation between the reduction technique and remplissage (p=0.91). At 90 degrees of ABER, the intact specimens average joint stiffness was 7.0±1.0N/mm, which was not significantly different from the remplissage (7.8±0.9 N/mm; p=0.9) and reduction technique (9.1±0.6 N/mm; p=0.50). Compared with an isolated Bankart repair, the average external rotation loss after also performing a remplissage procedure was 4.3±3.5 deg (p=0.65), while average ER loss following HS
reduction was 1.1±3.3 deg (p=0.99). There was no significant difference in external rotation between remplissage and the reduction technique (p=0.83).

**Conclusion:** Similar joint stability was conferred following both procedures, though remplissage had 3.2-degree loss of ER in comparison. While not statistically significant, even slight ER loss may be clinically detrimental in overhead athletes. Overall, the acute reduction technique is a more anatomic alternative to the remplissage procedure with similar ability to prevent dislocation in a biomechanical model, making it a viable treatment option for engaging Hill-Sachs lesions.

127 - Relationship Between Central Acetabular Osteophytes and Femoral Head Articular Damage – A Cross-sectional Study

**Parth Lodhia, BC; Chengcheng Gui, US; Timothy Martin, Netherlands; Sivashankar Chandrasekaran, BC; Carlos Suarez-Ahedo, Mexico; Benjamin G Domb, US**

**Comments:** We present to you a match-controlled study assessing co-existing arthroscopic findings during hip arthroscopy in patients with an intraoperative diagnosis of a central acetabular osteophyte (CAO). We feel that this manuscript is both pertinent and timely

**Purpose:** Recent literature has described the entity of central acetabular impingement, in which an osteophyte of the cotyloid fossa impinges against the superomedial femoral head and fovea. The technique for central acetabular decompression has also been described to treat this entity. The primary purpose of this study was to report the prevalence of femoral head articular damage in a matched cohort of patients with and without central acetabular osteophyte (CAO) that was identified during hip arthroscopy. A secondary purpose was to identify the rates of co-existing intraarticular pathology in both patient groups.

**Method:** Intraoperative data was collected prospectively on all patients undergoing hip arthroscopy at our institution between February 2008 to March 2015. The inclusion criteria for this study were the presence of a CAO identified during hip arthroscopy for a labral tear and/or femoroacetabular impingement (FAI). Exclusion criteria were revision surgeries, Tönnis grade 1 and higher, and previous hip conditions such as Legg-Calves-Perthes disease, avascular necrosis, and prior surgical intervention. The matched cohort control group was selected based on gender, age within 5 years, body mass index (BMI), and workers’ compensation claim, on a 1:3 ratio to patients who underwent hip arthroscopy for a labral tear and/or FAI and did not have a CAO.

**Results:** The CAO group consisted of 126 patients, which were matched to 378 patients in the control group. The grades of femoral and acetabular chondral damage were significantly different between the two groups (p<0.01).

**Conclusion:** This study showed that patients with CAO had a significantly higher prevalence of femoral and acetabular chondral damage, size of articular defects on both surfaces and the prevalence of LT tears compared to matched controls.
**Paper Session:** COA Foot and Ankle

128 - Increased Swelling Results in Poor Outcome After Ankle Arthritis Surgery  
**Alastair S.E. Younger, BC;** Tim Daniels, ON; Kevin Wing, BC; Murray Penner, BC; Andrea Veljkovic, BC; Hubert Wong, BC; Peter Dryden, BC; Mark Glazebrook, NS

**Purpose:** Patients often comment on swelling after foot and ankle surgery. However, the relationship between swelling and outcome (pain and function) has not previously been outlined. A recent study by Pinsker and Daniels demonstrated that while swelling was rated as important by patients, it was rarely included in outcome scores. The purpose of this paper was to determine the relationship between swelling and outcome after ankle fusion or replacement. A secondary purpose was to determine how this relationship changed in time, how swelling score changed before and after surgery, and determine differences in swelling score between total ankle replacement (TAR), open ankle arthrodesis (OAA) and arthroscopic ankle arthrodesis (AAA).

**Method:** The COFAS prospective ankle arthritis database enrolls patients in 4 centers undergoing surgery by one of 6 surgeons since 2002. The MODEMS outcomes package from AAOS was used, with the validated ankle osteoarthritis score (AOS) score being used to assess outcomes in the pain and disability domains. The swelling score was indexed from 1 to 5, 1 being no swelling and 5 being severe swelling. Outcomes were recorded preoperatively and annually up to 2010. Statistical analysis was performed using 95% confidence intervals and correlations being determined using Pearson’s correlation and r² values.

**Results:** The swelling score was correlated with AOS score with an r² of 0.13 for postoperative patients. With the swelling score analysed categorically, the difference of outcome was significant with a mean AOS score of 15.1 (CI 13.3 to 16.9) for a swelling score of 1, 23 (CI 21.7 to 24.9) for a swelling score of 2, 31 (CI 29.6 to 33.1) for 33.6 (CI 34.9 to 38.8) for 4, and 39 (CI 35.3 to 43.0) for 5. Swelling scores fell outside the 95% confidence intervals for all groups indicating that the AOS outcome of swelling score 5 patients was worse than the 4 group, 4 worse than 3, 3 worse than 2, and 2 worse than 1. Patients with swelling scores of 1 scored 24 points better than those with a swelling score of 5.

Swelling scores were the same preoperatively for total ankle arthroplasty, Arthroscopic and open fusions. However, swelling scores were lower for arthroscopic fusions after surgery for all time periods at an average of 2.1 (CI 1.9 to 2.2), compared to total ankle arthroplasty (2.5, CI 2.4 to 2.6) and open ankle fusion (2.5, CI 2.4 to 2.6).

**Conclusion:** Swelling has a major relationship with outcome. Swelling may be the cause of poorer outcomes for open ankle fusion compared to arthroscopic. Swelling is an independent factor as swelling scores for TAA were higher compared to AAA despite similar outcomes. Arthroscopic surgery reduces the postoperative swelling. Methods to reduce swelling such as compression stockings, elevation, controlling bleeding may result in better outcomes. Minimizing the invasiveness of surgery achieves this goal. Patient education about swelling, elevation and compression stockings would assist in these goals.
**129 - Can Pre-operative Risk Factors be Used to Predict Unplanned Admission or Readmission Rates? A Study of Foot and Ankle Patients**

*James R Rofaiel, ON; Ryan N Katchky, ON; Tate Newmarch, ON; Raja Rampersaud, ON; Johnny T Lau, ON*

**Purpose:** In the current health care climate, there is an increasing focus on cost savings and resource management. As such, there is an emphasis on decreasing length of stay and performing surgery on an outpatient basis. Consequently, some patients will have unanticipated intra-operative or post-operative adverse events that will necessitate an unplanned post-operative hospital admission or a readmission after discharge. These unplanned admissions or readmissions represent an increased burden on health care systems and can cause cancellation of other scheduled procedures. The purpose of this study is to investigate whether pre-operative patient risk factors or intra-operative events could predict unplanned admission or readmission following discharge in patients undergoing either elective or emergency foot and ankle surgery.

**Method:** Data was prospectively collected on a total of 889 patients. The patients were divided into two groups: patients without readmissions (N=791) and patients who had an unplanned admission or readmission (N=98). We also collected and analyzed the following variables: age, gender, BMI, diabetes, ASA class, surgery start time, length of surgery, regional vs. general anesthetic, elective vs. trauma surgery and type of procedure. Logistic regression models were used to identify risk factors that could independently predict unplanned admissions or readmissions to hospital following foot and ankle surgery.

**Results:** Factors that could be used to independently predict readmission were length of surgery (p=0.0154, Odds Ratio 1.004) and trauma surgery (0.0167; 1.978). For every 1-hour increase in length of surgery, the odds of unplanned admission/readmission increase by 1.27 times. The odds of patients undergoing surgery for acute traumatic injuries getting readmitted are 1.978 times higher than for elective surgery patients.

**Conclusion:** In conclusion, our study showed that pre-operative patient risk factors including BMI, diabetes, and ASA status were unable to predict whether patients would have an unplanned admission or readmission. The two factors that were able to predict whether patients would have an unplanned admission or readmission were length of the procedure and trauma surgery – both of which are not readily modifiable. Our results showed that in spite of institutional measures to ensure timely discharge, only 11% of patients required an unplanned admission or readmission.

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**130 - Preoperative Patient and Institutional Factors Influence Anaesthetic Type in Foot and Ankle Surgery**

*Ryan N Katchky, ON; James R Rofaiel, ON; Tate K Newmarch, ON; Raja Rampersaud, ON; Johnny T Lau, ON*

**Purpose:** Lower-extremity orthopaedic procedures may be performed under either regional or general anaesthesia, or a combination of both techniques. There is a growing body of evidence supporting the benefits of regional anaesthesia, with meta-analyses of randomized controlled trials and registry data suggesting decreases in deep surgical site infections, thromboembolic events, cardiopulmonary...
complications and length of stay associated with use of regional anaesthesia. In patients undergoing foot and ankle surgery specifically, there is evidence demonstrating decreased post-operative pain, nausea, vomiting, opioid use and unplanned hospital admission. This supports an increased role for the use in regional anaesthesia in patients undergoing foot and ankle surgery. However, the type of anaesthetic used is dependent on surgeon, patient, anaesthesiologist and institutional factors. The purpose of this study is to investigate pre-operative factors that predict the type of anaesthetic used in patients undergoing foot and ankle surgery.

Method: Data was collected prospectively on 888 patients undergoing foot or ankle surgery at a single institution. The primary method of anaesthesia for each procedure was recorded. Ten additional variables were recorded and analyzed: age, BMI, gender, diabetes, ASA status, procedure length, procedure start time, elective vs. trauma procedure, primary vs. revision procedure and preoperative anticoagulation. Logistic regression modelling was performed to identify factors that independently predict the type of anaesthetic used.

Results: General anaesthetic was employed in 280 patients (32%), and regional anaesthesia was the primary anaesthetic type used in 608 (68%). Logistic regression modelling demonstrated that factors that independently predict use of general anaesthetic include younger age (p<0.0001; Odds Ratio 0.97/year), male sex (0.0033; 1.618), procedure start time (0.0319; 1.066/hour) and length of procedure (<0.0001; 1.520/hour). Patients who underwent general anaesthetic had a mean length of procedure of 108 ± 77 minutes, whereas patients provided with regional anaesthesia had a mean length of procedure 83 ± 64 minutes.

Conclusion: With increasing evidence supporting the benefits of regional anaesthesia in patients undergoing lower extremity surgery, it is important to identify modifiable factors that contribute to patients receiving alternative treatments. Since later procedure start time was identified as an independent predictor of general anaesthetic use, there may be a role for identifying patients at increased risk of complications associated with general anaesthesia and scheduling earlier start times. Furthermore, while it is logical that extended length of procedure may be a contraindication to regional anaesthesia, the mean procedure time of 108 minutes in the general anaesthesia group indicates that many of these patients should still be considered candidates for regional anaesthesia.

131 - Resource Utilization after Surgery for End-stage Ankle Arthritis: Comparison Between Ankle Replacement, Open and Arthroscopic Ankle Fusion
Alastair S.E. Younger, BC; Jacqueline T Ngai, BC; Murray J Penner, BC; Andrea Veljkovic, BC; Kevin J Wing, BC; Hubert Wong, BC

Purpose: As an alternative to ankle replacement, ankle arthrodesis remains a mainstay in the treatment of end-stage arthritis. Arthroscopic techniques for ankle arthrodesis have more recently been developed, although there has been limited research exploring the cost of arthroscopic (AAA) versus open ankle arthrodesis (OAA), and comparing ankle fusions to replacement (TAA). We hypothesize that resource use after AAA will be lower than that after OAA, and both will be lower than TAA.
Method: We performed a retrospective review of a prospectively collected database. The COFAS database was used to identify patients with >2 years of follow up who have undergone AAA, OAA or Hintegra TAA at St Paul’s Hospital between 2003-2010. Ninety patients with TAA, 52 with AAA and 56 with OAA met our inclusion criteria. The following data were documented: patient demographics (age, gender, presence of diabetes, inflammatory arthritis or any smoking history), factors related to the index surgery (type of surgery, OR time, length of stay) and factors relating to the post-operative course (number of post-operative clinic visits, OR time for re-operations, length of stay for additional hospital admissions).

Results: In terms of the index surgery, AAA required less initial OR time compared to either OAA or TAA. Initial length of hospital stay was significantly longer for both TAA and OAA, compared to AAA. Patients attended more follow-up visits after TAA or OAA compared to after AAA. In terms of additional OR time required, no significant differences were found among the groups. The most common reason for re-operation was infection or wound breakdown (38% of re-operations), followed by removal of hardware (15%). TAA also required significantly more additional days in hospital compared to either OAA or AAA. For all significant comparisons, p < 0.05. For each primary TAA, on average an additional one hour of surgery, three days in hospital and seven clinic visits were required on top of the cost factored for the primary arthroplasty. For each primary AAA, an additional four clinic visits, 23 minutes of revision surgery and one day in hospital were required. For each primary OAA, an average additional five clinic visits, three minutes of OR time, and 0.2 days of additional hospital stay occurred during follow up.

Conclusion: Using several measures of resource use, we find that arthroscopic ankle fusions compare favourably to both ankle replacements and open ankle fusions. We also show that resource utilization measurements can be a useful surrogate for complications, and that resource utilization can demonstrate the practical implications of complications for patients, surgeons and health care resources.

Practice Patterns in the Care of Acute Achilles Tendon Ruptures: Is There an Association with Level I Evidence?

Ujash Sheth, ON; David Wasserstein, ON; Rahim Moineddin, ON; Richard Jenkinson, ON; Hans Kreder, ON; Susan Jaglal, ON

Purpose: Over the last decade, there has been a growing body of level I evidence supporting non-operative management (focused on early range of motion and weight bearing) of acute Achilles tendon ruptures. Despite this emerging evidence, there have been very few studies evaluating its uptake. Our primary objective was to determine whether the findings from a landmark Canadian trial assessing the optimal management strategy for acute Achilles tendon ruptures influenced the practice patterns of orthopaedic surgeons in Ontario, Canada over a 12-year time period. As a second objective we examined whether patient and provider predictors of surgical repair utilization differed before and after dissemination of the landmark trial results.

Method: Using provincial health administrative databases, we identified Ontario residents 18 years of age and older with an acute Achilles tendon rupture from April 2002 to March 2014. The proportion of surgically repaired ruptures was calculated for each calendar quarter and year. A time-series analysis
using an interventional autoregressive integrated moving average (ARIMA) model was used to determine whether changes in the proportion of surgically repaired ruptures were chronologically related to the dissemination of results from a landmark Canadian trial by Willits et al. (first quarter, 2009). Spline regression was then used to independently identify critical time-points of change in the surgical repair rate to confirm our findings. A multivariate logistic regression model was used to assess for differences in patient and provider predictors of surgical repair utilization before and after the landmark trial.

**Results:** From the second quarter of 2002 to the first quarter of 2010 the surgical repair rate remained constant at ~21%, however, by the first quarter of 2014 it fell to 6.5%. A statistically significant decrease in the rate of surgical repair (P<0.001) was observed after the results from a landmark Canadian trial were presented at a major North American conference (February 2009). Both teaching and non-teaching hospitals demonstrated a decline in the surgical repair rate over the study period, however, only the decrease seen at non-teaching hospitals was found to be significantly associated with the dissemination of landmark trial results (P<0.001). All other predictors of surgical repair utilization remained unchanged in the before-and-after analysis with the exception of patients 30 years of age and younger having a higher odds of undergoing surgical repair after the trial when compared to those 51 years of age and older.

**Conclusion:** The current study demonstrates that large, well-designed randomized trials, such as the one conducted by Willits et al. can significantly change the practice patterns of orthopaedic surgeons. Moreover, the decline in surgical repair rate observed at both teaching and non-teaching hospitals suggests both academic and non-academic surgeons readily incorporate high quality evidence in to their practice.

**133 - Gender Differences in End Stage Ankle Arthritis**  
**Andrew Dodd, ON; Ryan Khan, ON; Ellie Pinsker, ON; Timothy Daniels, ON**

**Purpose:** End-stage ankle arthritis (ESAA) is a debilitating disease that does not affect all individuals equally. Gender differences have been identified in patients with end-stage hip and knee arthritis and have stimulated research to explain these findings. The present study was undertaken to examine if gender has a significant effect on pre-operative disability and post-operative outcomes in patients with ESAA.

**Method:** Patients undergoing ankle arthrodesis (AA) or total ankle replacement (TAR) with minimum 2-year follow-up were identified in the Canadian Orthopaedic Foot and Ankle Society prospective ankle reconstruction database. Demographic data, revision data, patient satisfaction questionnaires, and outcome data using the Ankle Osteoarthritis Scale (AOS) and Short-form 36 (SF-36) health survey were collected.

**Results:** TAR: 384 patients were included, with 198 females and 186 males. Patient BMI, comorbidities, and duration of follow-up were similar between groups. Males were slightly older at the time of surgery (65.1 vs 62.4 years, p=0.01)). The most common etiology was post-traumatic arthritis for both genders, however females had a higher rate of rheumatoid arthritis (17% vs 5%, p=0.001). Implant types included
STAR, Hintegra, and Mobility, and were similar between groups. Preoperatively females had higher rates of pain and disability, demonstrated by lower SF-36 physical component scores (PCS) (31.0 vs 34.5, \( p<0.001 \)), and higher AOS pain (54.7 vs 51.1, \( p=0.05 \)) and AOS disability scores (66.5 vs 59.6, \( p<0.001 \)). Postoperatively, both groups had significant improvement in PCS, AOS pain, and AOS disability scores. Females, however, continued to demonstrate lower PCS scores (38.3 vs 41.9, \( p<0.001 \)) and higher AOS disability (31.0 vs 25.8, \( p=0.02 \)) than males. Regression analysis found that preoperative PCS, gender, age, and arthritis etiology all had a significant impact on postoperative PCS scores, with preoperative PCS scores having the largest impact. Preoperative AOS pain and disability scores had the largest impact on postoperative AOS pain and disability scores, respectively. Gender had no significant impact on AOS pain and disability scores postoperatively. Patient satisfaction was similar between males and females postoperatively. Secondary surgery was performed in 13.6% of females and 16.1% of males. Five males and five females underwent revision to arthrodesis.

AA: Results Pending

**Conclusion:** In patients with ESAA, females tend to have higher pre-operative levels of pain and disability compared to males, which persists post-operatively. This is consistent with the hip and knee arthroplasty literature. This finding may be due to females undergoing surgery at more advanced disease states, arthritis etiology, referral bias, or treatment bias. Both males and females have significant and similar degrees of improvement in pain and disability scores after TAR, and reoperation rates and patient satisfaction rates are similar despite the apparent disparity in outcomes.

134 - A New Innovative Intra-operative Test for Syndesmosis Instability Detection in Supination-external Rotation (SER) Injuries

Nayla Maria Gosselin-Papadopoulos, QC; Yves Laflamme, QC; Jeremie Menard, QC; Dominique Rouleau, QC; Stephane Leduc, QC; Jonah Davies, QC; Marie-Lyne Nault, QC

**Purpose:** Reoperations may be a better way of tracking adverse outcomes than complications. Repeat surgery causes cost to the system, and often indicate failure of the primary procedure resulting in the patient not achieving the expected improvement in pain and function. Understanding the cause of repeat surgery at the primary site may result in design improvements to implants or improvements to fusion techniques resulting in better outcomes in the future. The COFAS group have designed a reoperation classification system. The purpose of this study was to outline the inter and intra observer reliability of this classification scheme.

**Method:** To verify the inter- and intra-observer reliability of this new coding system, six fellow ship trained practicing foot and ankle Orthopaedic surgeons were asked to classify 62 repeat surgeries from a single surgeons practice. The six surgeons read the operation reports in random order, and reread the reports 2 weeks later in a different order. Reliability was determined using intraclass correlation coefficients (ICC) and proportions of agreement. The agreement between pairs of readings (915 for inter observer for the first and second read – 61 readings with 15 comparisons, observer 1 with observer 2, observer 1 with observer 3, etc) was determined by seeing how often each observer agreed. This was repeated for the 366 ratings for intra observer readings (61 times 6).
Results: The inter-observer reliability on the first read had a mean intra-class correlation coefficient (ICC) of 0.89. The range for the 15 comparisons was 0.81 to 1.0. Amongst all 1830 paired codings between two observers, 1605 (88%) were in agreement. Across the 61 cases, 45 (74%) were given the same code by all six observers. However, the difference when present was larger with more observers not agreeing. The inter-observer reliability test on the second read had a mean ICC of 0.94, with a range of 0.90. There were 43 (72%) observations that were the same across all six observers. Of all pairs (915 in total) there was agreement in 804 pairs for the first reading (88%) and disagreement in 111 (12%). For the second reading there was agreement in 801 pairs (86%) and disagreement in 114 (14%). The inter-observer reliability averaged an ICC value of 0.92, with a range of 0.86 to 0.98. The observers agreed with their own previous observations 324 times out of 366 paired readings (89% agreement of pairs).

Conclusion: The COFAS classification of reoperations for end stage ankle arthritis was reliable. This scheme potentially could be applied to other areas of Orthopaedic surgery and should replace the Claiden Dindo modifications that do not accurately reflect Orthopaedic outcomes. As complications are hard to define and lack consistent terminology reoperations and resource utilization (extra clinic visits, extra days in hospital and extra hours of surgery) may be more reliable measures of the negative effects of surgery.

135 - Reliability of the COFAS Reoperation Classification System
Alastair S.E. Younger, BC; Murray Penner, BC; Mark Glazebrook, NS; Gord Goplen, AB; Tim Daniels, ON; Andrea Veljkovic, BC; Karl Lalonde, ON; Kevin Wing, BC; Peter Dryden, BC; Hubert Wong, BC

Purpose: Reoperations may be a better way of tracking adverse outcomes than complications. Repeat surgery causes cost to the system, and often indicate failure of the primary procedure resulting in the patient not achieving the expected improvement in pain and function. Understanding the cause of repeat surgery at the primary site may result in design improvements to implants or improvements to fusion techniques resulting in better outcomes in the future. The COFAS group have designed a reoperation classification system. The purpose of this study was to outline the inter and intra observer reliability of this classification scheme.

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of 0.90. There were 43 (72%) observations that were the same across all six observers. Of all pairs (915 in total) there was agreement in 804 pairs for the first reading (88%) and disagreement in 111 (12%). For the second reading there was agreement in 801 pairs (86%) and disagreement in 114 (14%). The intra-observer reliability averaged an ICC value of 0.92, with a range of 0.86 to 0.98. The observers agreed with their own previous observations 324 times out of 366 paired readings (89% agreement of pairs).

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**136 - Measurement Properties of Total Ankle Replacement Outcome Measures: A Systematic Review**

Ellie Pinsker, ON; Taucha Inrig, ON; Phillip Daniels, ON; Timothy R. Daniels, ON; Dorcas E. Beaton, ON

**Purpose:** Researchers and clinicians measuring outcomes following total ankle replacement (TAR) are challenged by the wide range of outcome measures used in the literature without consensus as to which are valid, reliable, and responsive in this population. This review identifies region- or joint-specific outcome measures used for evaluating TAR outcomes and synthesizes evidence for their measurement properties.

**Method:** A standard search strategy was conducted of electronic databases MEDLINE, EMBASE and CINAHL (to June 2015) to identify foot/ankle measures in use. A best evidence synthesis approach was taken to critically appraise measurement properties [COnsensus-based Standards for the selection of health Measurement INstruments (COSMIN)] of identified measures. The review was restricted to English publications and excluded cross-cultural adaptations. Measurement properties collected from each article were coded for validity, reliability, responsiveness, or interpretability. Clinimetric evidence exists for identified measures tested in non-TAR populations, but were not the focus of this review.

**Results:** The search identified 14 studies to include in the best evidence synthesis with 32 articles providing clinimetric evidence for eight of the measures (one CBO, seven PRO), however only five measures were tested in a TAR population (Foot Function Index, Ankle Osteoarthritis Scale, American Orthopaedic Foot and Ankle Society Ankle-Hindfoot Scale [AOFAS], Foot and Ankle Outcome Score, Self-Reported Foot and Ankle Score). Five studies provided clinimetric evidence in a TAR population and their methodological quality was assessed: (1) Validity—two good quality studies examining different measures provide moderate evidence supporting construct validity (FFI, AOS, AOFAS self-reported items; SEFAS); (2) Reliability—two good quality studies examining different measures provide moderate evidence supporting internal consistency and test-retest reliability (FFI, AOS, AOFAS self-reported items; FAOS, SEFAS); (3) Responsiveness—three poor quality studies, thus unknown evidence for responsiveness; (4) Interpretability—two studies provide interpretability values (AOS, FFI, AOFAS self-reported items; AOS).
Conclusion: This review offers a basis for choosing the most appropriate instrument for evaluating TAR outcomes. Numerous outcome measures were identified with evidence supporting their use in populations with various foot/ankle conditions, but none have strong evidence supporting use in a TAR population. Measures must have adequate clinimetric properties in all patient groups in which they are applied. Evidence supporting or critiquing an instrument should not be based on studies with poor quality methodology, as identified by this review. Further testing in a TAR population would benefit identified measures with emphasis on adequate sample sizes, testing a priori hypotheses, and evaluating their content validity for a TAR population.
**137 - Frequency of Crouch Gait in Spastic Diplegic Patients With and Without History of Tendo Achilles Lengthening**

**Lise Leveille, BC; Ashley Erdman, US; Kelly Jeans, US; Kristin Tulchin-Francis, US; Lori Karol, US**

**Purpose:** The natural history of gait pattern change in children with spastic diplegia is a transition from toe walking to progressive hip and knee flexion with eventual crouch gait. This has been attributed to the adolescent growth spurt, progressive lever arm dysfunction, and iatrogenic weakening of the soleus with isolated tendo achilles lengthening (TAL). The relative contribution of TAL to the development of crouch gait is uncertain. The purpose of this study was to identify the frequency of crouch gait in spastic diplegic patients with and without history of prior TAL.

**Method:** Patients with spastic diplegia greater than 10 years of age with instrumented gait analysis were reviewed. Exclusion criteria included diagnosis other than cerebral palsy, prior dorsal root rhizotomy, or incomplete past surgical history. Patients were divided into three groups: Group 1, no prior orthopaedic surgical intervention; Group 2, prior orthopaedic surgery without TAL; Group 3, prior orthopaedic surgery with TAL. Instrumented gait analysis data was analyzed. Gait data were analyzed using a single randomized limb from each patient.

**Results:** One hundred and seventy-eight patients were identified: 39 in Group 1, 49 in Group 2, and 90 in Group 3. Mean time from TAL to gait analysis was 7.5 years (range 1.0-14.6 years). Mean age at TAL was 6.3 years (range 1.2-17.5 years). There was no significant difference in age, BMI, walking speed, or cadence between groups. Kinematic analysis showed no significant difference in mean stance phase maximum knee or ankle flexion between groups. There was no significant difference in frequency of increased mid stance knee flexion between groups (Group 1, 53.8%; Group 2 46.9%; Group 3, 43.3%, p=0.546). There was a trend towards increased frequency in excessive stance phase ankle dorsiflexion in Group 3 (60% Group 3 vs 46.2% Group 1, and 40% Group 2, p=0.071). Crouch gait (stance minimum hip flexion > 30, mid stance minimum knee flexion > 200, and stance maximum ankle dorsiflexion > 150) was seen with similar frequency in all groups (Group 1, 23.1%; Group 2, 18.4%; Group 3, 26.7%; p=0.544).

**Conclusion:** There is a trend towards increased frequency of excessive stance phase ankle dorsiflexion in spastic diplegic patients with prior TAL. However, no significant difference in frequency of crouch gait between patients with and without history of TAL was identified. Crouch gait is part of the natural history of gait pattern change in spastic diplegic patients independent of prior surgical intervention.

**138 - A Biomechanical Comparison Of Suture-external Button Fixation versus Internal Suspension Fixation for Tendon Transfers in Children**


**Purpose:** Fixation of tendon transfers about the foot in children typically involves creating a bone tunnel through which a suture is passed and tied over an external button. An internal suspension system, such as the Endobutton (Smith & Nephew) is an alternative fixation method which has demonstrated
excellent fixation strength and minimal intraosseous tunnel displacement in various adult procedures. Application of the Endobutton technique has no risk of skin ulceration, does not require suture removal and may provide more secure fixation. The purpose of this study is to compare the biomechanical properties of the external button and Endobutton fixation techniques. Our primary outcome measure was intra-osseous displacement of the suture, during both static and dynamic loading, in cadaver feet.

Method: Nine adult cadaver feet were utilized. A bone tunnel was drilled in the lateral cuneiform and #1 braided non-absorbable suture was passed through the tunnel. One end was secured to a carabiner to be attached to the materials testing system and the other to the fixation device. The external button and Endobutton fixation techniques were tested once in each cadaver, randomizing the order of testing to minimize bias. Each fixation technique underwent static and dynamic cyclic loading. A custom Matlab script was used to process video and materials testing system data. The relative displacement of the suture within the bone tunnel, as a function of time and load magnitude, was recorded during static and dynamic cyclic loading. Both fixation groups were analyzed and compared for statistical significance using a paired T-test and an alpha value of 0.05.

Results: The Endobutton group had significantly less displacement within the bone tunnel, during both static and dynamic loading, than the external button. The average displacement during static loading was 0.42 mm for the Endobutton and 2.17 mm for the external button (p=0.0019). Similarly, during dynamic cyclic loading, the mean displacement was 0.32 mm for the Endobutton and 0.66 mm for the external button (p=0.0115).

Conclusion: The Endobutton internal suspension technique demonstrates significantly less displacement during static and dynamic loading than the external button, during biomechanical testing in cadaver feet. The Endobutton may provide superior fixation than the traditional external button technique for tendon transfers in children. In addition, this technique avoids the risk of skin ulceration from the button and the need for suture removal.

139 - Early MRI Detection and Closed Bone Graft Epiphysiodesis May Alter the Course of Avascular Necrosis Following Unstable Slipped Capital Femoral Epiphysis

Purpose: Unstable slipped capital femoral epiphysis (SCFE) has an increased incidence of avascular necrosis (AVN). The purpose of this study was to determine if early identification and intervention for AVN may help preserve the femoral head.

Method: We retrospectively reviewed 48 patients (50 hips) with unstable SCFE managed between 2000 and 2014. Based on two different protocols during the same time period, 17 patients (17 hips) had a scheduled MRI between 1 and 6 months from initial surgery, with closed bone graft epiphysiodesis (CBGE) or free vascularized fibular graft (FVFG) if AVN was diagnosed. Thirty-one patients (33 hips) were evaluated by plain radiographs. Outcomes analyzed were Steinberg classification and subsequent surgical intervention. We defined Steinberg class IVC as failure in treatment because all of the patients referred for osteotomy, arthroplasty, or arthrodesis in our study were grade IVC or higher.
**Results:** Overall, 13 hips (26%) with unstable SCFE developed AVN. MRI revealed AVN in 7 of 17 hips (41%) at a mean of 2.5 months postoperatively (range, 1.0 to 5.2 months). Six hips diagnosed by MRI received surgical intervention (4 CBGE, 1 FVFG, and 1 repinning due to screw cutout) at a mean of 4.1 months (range, 1.3 to 7.2 months) postoperatively. None of the 4 patients treated with CBGE within two months postoperatively progressed to stage IVC AVN. The two patients treated after four months postoperatively both progressed to stage VC AVN. Radiographically diagnosed AVN occurred in 6 of 33 hips (18%) at a mean of 6.8 months postoperatively (range, 2.1 to 21.1 months). One patient diagnosed with stage IVB AVN at 2.4 months had screw cutout and received CBGE at 2.5 months from initial pinning. The remaining 5 were not offered surgical intervention. Five of the 6 radiographically diagnosed AVN, including the one treated with CBGE, progressed to stage IVC AVN or greater.

**Conclusion:** None of the 4 patients with unstable SCFE treated with CBGE within 2 months post pinning developed grade IVC AVN, while all patients treated with other procedures after 2 months developed IVC or greater AVN. Early detection and treatment of AVN after SCFE may alter the clinical and radiographic progression.

**140 - Epidemiology of Developmental Hip Dysplasia in Saskatchewan**
Susan E Nelson, SK; Katie Rooks, SK; Anne Dzus, SK; Lauren Allen, SK

**Purpose:** Developmental dysplasia of the hip (DDH) refers to a spectrum of anatomical abnormalities. Despite various screening programs, delayed diagnosis still occurs. Delayed cases are more difficult to treat and can have poorer outcomes. Rural address, low socioeconomic status, and ethnicity have recently been associated with late presentation. The objectives of this study were to examine the incidence of DDH, as well as factors associated with delayed presentation in Saskatchewan.

**Method:** Retrospective review of paediatric orthopaedic records from the tertiary referral center in Saskatchewan was completed from 2008-2014. Variables collected included age at presentation, sex, birth order, birth presentation, birth complications, laterality, family history of DDH, postal code and treatment. Socioeconomic and geographic indicators were determined from postal code using the 2011 National Household Survey. Population level variables included income, ethnic origin, distance from referral center and education. Associations were examined with bivariate and multivariate analysis.

**Results:** There were 108 new presentations of DDH; 34 cases presented after age 3 months. Demographic data showed 83.3% of cases were female, 48.1% involved the left hip, 17.2% had a positive family history, 57.1% were first born, and 27.9% were breech. An estimated 5.6% of patients were Aboriginal. The mean age at presentation was 199.7 days. 48% of cases lived in the same city as the referral center. Late presenting cases lived on average 46.19 km farther from the referral center and had a lower mean population, percent of adults with post-secondary education and income. However, none of these were statistically significant. No significant associations were found within the demographic data.

**Conclusion:** Overall incidence of DDH was not estimated due to few cases from southern areas of the province presenting to the tertiary referral center. The estimated incidence of DDH in the Aboriginal population from our sample was lower than previously reported in the literature. This association may
be related to earlier swaddling practices, rather than Aboriginal ethnicity. There was a trend toward lower socioeconomic indicators and an increased distance from the referral center in cases of late presentation, in keeping with recent literature exploring these factors. This suggests there may be deficits in the current selective screening protocols in North America. The study is limited by the retrospective nature of the research and the population level data obtained for certain variables. Future research to collect prospective individual level data may help elucidate important associations. Also, identifying any additional cases would increase the power to detect significant associations with late presentation, and allow an accurate estimate of overall incidence.

141 - Rebound Deformity After Growth Modulation in Patients with Coronal Plane Angular Deformities About the Knee: Who Gets it and How Much?
Lise Leveille, BC; Ozan Razi, US; Charles Johnston, US

Purpose: With observed success and increased popularity of growth modulation techniques, there has been a trend towards use in progressively younger patients. Younger age at growth modulation increases the likelihood of complete deformity correction and need for implant removal prior to skeletal maturity introducing the risk of rebound deformity. The purpose of this study was to quantify magnitude and identify risk factors for rebound deformity after growth modulation.

Method: We performed a retrospective review of all patients undergoing growth modulation with a tension band plate for coronal plane deformity about the knee with subsequent implant removal. Exclusion criteria included completion epiphysiodesis or osteotomy at implant removal, ongoing growth modulation, and less than one year radiographic follow-up without rebound deformity. Mechanical lateral distal femoral angle (mLDFA), mechanical medial proximal tibial angle (mMPTA), hip-knee-ankle angle (HKA), and mechanical axis station were measured prior to growth modulation, prior to implant removal, and at final follow-up.

Results: Sixty-seven limbs in 45 patients met the inclusion criteria. Mean age at growth modulation was 9.8 years (range 3.4-15.4 years) and mean age at implant removal was 11.4 years (range 5.3-16.4 years). Mean change in HKA after implant removal was 6.9O (range 0O-23 O). Fifty-two percent of patients had greater than 5O rebound and 30% had greater than 10O rebound in HKA after implant removal. Females less than ten years and males less than 12 years at time of growth modulation had greater mean change in HKA after implant removal compared to older patients (8.4O vs 4.7O, p=0.012). Patients with initial deformity greater than 20O degrees had an increased frequency of rebound greater than 10O compared to patients with less severe initial deformity (78% vs 22%, p=0.002).

Conclusion: Rebound deformity after growth modulation is common. Growth modulation at a young age and large initial deformity increases risk of rebound. However, rebound does not occur in all at risk patients, therefore, we caution against routine overcorrection. Patients and their families should be informed about the risk of rebound deformity after growth modulation and the potential for multiple surgical interventions prior to skeletal maturity.

142 - Peroneal Nerve Function Before and Following Surgical Excision of a Proximal Fibular Osteochondroma
Kevin Smit, ON; Craig Birch, US; Dan Sucato, US

**Purpose:** Osteochondromas occur most commonly in the distal femur, proximal tibia and fibula and the proximal humerus. There are no large studies focusing on the clinical presentation, management and outcome of treatment for patients with an osteochondroma involving the proximal fibula. The purpose of this study is to specifically understand the manifestation of the proximal fibular osteochondroma on the preoperative peroneal nerve function, and how surgical management of the osteochondroma affects function immediately postoperatively and at long-term followup.

**Method:** This is an IRB-approved retrospective review of a consecutive series of patients with a proximal fibular osteochondroma (PFO) treated operatively at a single institution from 1990 to 2013. The medical record was carefully reviewed to identify demographic data, clinical data and especially the status of the peroneal function at various time points.

**Results:** There were 25 patients with 31 affected extremities who underwent surgical excision of the PFO at an average age of 12.4 years (range 3.0-17.9 years). There were 16 males and 9 females. The underlying diagnosis was isolated PFO in 2(8%) patients and multiple hereditary exostosis (MHE) in 23(92%) patients. Preoperatively, 9 (29%) had a foot drop and 22 (71%) did not. Those with preoperative foot drop underwent surgery at a younger age (9.1 vs 13.8 years) (p<0.004). Five of the nine (55.5%) had complete resolution, three (33.3%) had improvement, and one (11.1%) persisted postoperatively and required AFO. Of the 22 who were normal preoperatively, 5 (22.7%) developed a postoperative foot drop- three (60%) completely resolved, 1 (20%) improved, and 1 (20%) persisted and was found to have a transected nerve at exploration. In total, 23 of the 25 (92%) patients who had a PFO excision, had a normal or near-normal peroneal nerve function including those who had poor function preoperatively.

**Conclusion:** A proximal fibular osteochondroma can result in a high incidence of peroneal nerve dysfunction prior to any treatment, but responds the majority of the time to surgical intervention with removal of the osteochondroma. For those who have normal preoperative function, 1 in 4 will develop a postoperative foot drop but nearly all improve spontaneously unless iatrogenic injured.

143 - Osteochondritis Dissecans of the Knee in Paediatric Patients: Does MRI Instability Indicate the Need for Surgical Intervention?

Devin C. Peterson, ON; Simon Haeri Hendy, ON; Darren de SA, ON; Kelly Ainsworth, ON; Olufemi R Ayeni, ON; Nicole Simunovic, ON

**Purpose:** To determine if there are osteochondritis dissecans (OCD) lesions of the knee that are so unstable on MRI that they are incapable of healing without operative intervention. A secondary objective was to determine the ability of orthopaedic residents to accurately grade OCD lesions according to the Kijowski criteria of stable and unstable.

**Method:** A retrospective review was performed of patients who had femoral condyle OCD lesions from 2009-present. Only patients with open growth plates and serial MRIs were included. Each MRI was classified according to the Kijowski classification by a junior orthopaedic surgery resident as well as an MSK trained radiologist. A weighted kappa value was used to assess the inter-rater agreement.
Results: The final analysis included 16 patients (17 knees) with 49 MRI’s. The weighted kappa agreement between reviewers for overall lesion stability was moderate (0.570 [95% CI 0.237-0.757]). The initial MRI lesion was graded as stable in 59% (10/17) of the knees. Two of these 10 knees became unstable during the study period, however, both stabilized again on subsequent MRIs, one with surgery and the other without surgery. The initial MRI was graded as unstable in 41% (7/17) of the knees. Two of the seven knees (29%) later demonstrated MRI evidence of lesion stability without surgical intervention.

Conclusion: The most important finding in this study was the ability of unstable OCD lesions on MRI to heal without operative intervention. The ability of an orthopaedic surgery resident to grade these lesions on MRI was moderate.

144 - Developmental Dysplasia of the Hip and Laterality: The Importance of Graded Severity of the Contralateral Hip
Emily Schaeffer, BC; Charles Price, US; Kishore Mulpuri, BC; IHDI Study Group, US

Purpose: Laterality and bilaterality have been reported as prognostic variables in DDH outcomes. However, there is little clarity across the literature on the reporting of laterality in developmental dysplasia of the hip (DDH) due to the variability in severity of the condition. It is widely accepted that the left hip is most frequently affected; however, the true incidence of unilateral left, unilateral right and bilateral cases can be hard to quantify and compare across studies. The purpose of this study was to examine laterality accounting for graded severity in a multi-centre, international prospective observational study of infants with hip dysplasia in order to demonstrate the complexity of this issue.

Method: A multi-centre, prospective database of infants diagnosed with DDH between the ages of 0 and 18 months was analyzed from 2010 to April 2015. Patients less than six months were enrolled in the study if at least one hip was frankly dislocated. Patients between 6 and 18 months were enrolled if they had any form of hip dysplasia. Each hip was classified as reduced, dysplastic, dislocatable/subluxable, dislocated reducible or dislocated irreducible. Baseline diagnosis was used to classify patients into a graded laterality category accounting for hip status within the DDH spectrum.

Results: A total of 496 patients were included in the analysis; 328 were <6 months old at diagnosis and 168 were between 6 and 18 months old. Of these patients, 421 had at least one frankly dislocated hip. Unilateral left hip dislocations were most common, with 223 patients, followed by unilateral right and bilateral dislocations with 106 and 92 respectively. Stratifying these patients based on status of the contralateral hip, 54 unilateral left and 31 unilateral right dislocated patients also had a dysplastic or unstable contralateral hip. There were significantly fewer bilateral patients in the 6-18 month group (p=0.0005). When classifying laterality by affected hip, bilaterality became the predominant finding, comprising 42% of all patients.

Conclusion: The distribution of unilateral left, unilateral right and bilateral cases was greatly impacted by the method of classification. Distinct patterns were seen when considering dislocated hips only, or when considering both dislocated and dysplastic/unstable hips. Findings from this multi-centre prospective study demonstrate the necessity to account for the graded severity in hip status when reporting DDH laterality. In order to accurately compare laterality across studies, a standardized,
comprehensive classification should be established, as contralateral hip status may impact prognosis and treatment outcomes.

145 - Investigating Caregiver Perspectives on Health Status and Comfort in Children with Cerebral Palsy Undergoing Surgery for Hip Displacement
Kishore Mulpuri, BC; Stacey Miller, BC; Emily Schaeffer, BC; Maria Juricic, BC; Kim Hesketh, BC

Purpose: Hip displacement is the second most common deformity in children with cerebral palsy (CP). A displaced, and particularly a dislocated hip, can have significantly adverse effects on an individual. Surgical intervention to correct progressive hip displacement or dislocation is recommended for children with CP. Success of surgical intervention is often described using radiological outcomes. There is evidence that surgical treatment for displaced or dislocated hips decreases pain and hip stiffness and improves radiological outcomes. However, there is no information in the literature regarding the impact of surgical treatment on the health related quality of life (HRQOL) in these children. The aim of our study was to examine the impact of surgical treatment of hip displacement or dislocation on HRQOL in children with CP.

Method: This prospective longitudinal cohort study involved children attending a tertiary care hospital orthopaedic department. Children with CP between the ages of 4 and 18 years, with hip displacement/dislocation, defined as a Reimer’s migration percentage (MP) of >40% on a pre-operative x-ray, and undergoing surgical reconstruction were eligible for inclusion. Quality of life was measured pre-operatively and post-operatively using the CPCHILD Questionnaire.

Results: Twelve patients (one child was GMFCS level III, 4 were level IV, and 7 were level V), aged 4.0 to 17.3 years, were assessed pre-operatively and then again at least six months post-operatively. All underwent unilateral (5) or bilateral (7) reconstructive hip surgery. The migration percentage of hips undergoing reconstruction was reduced by an average of 52% (9-100%). The average change in CPCHILD score showed an increase of 6.4 points [95% CI: -1.4-14.2].

Conclusion: In this pilot study, no significant change was noted in HRQOL following reconstructive hip surgery, despite a marked reduction in Reimer’s MP. However, only 4 of 12 parents reported that their child had daily pain pre-operatively. A larger sample size will be required to draw more accurate conclusions from these findings. There is an evident need for a multicentre study examining this issue in a larger patient population in order to determine the long-term impact of different hip interventions on quality of life in children with CP.

146 - Automatic Evaluation of Scan Adequacy and Dysplasia Metrics in 2D Ultrasound Images of the Neonatal Hip
Emily Schaeffer, BC; Niamul Quader, BC; Kishore Mulpuri, BC; Anthony Cooper, BC; Antony Hodgson, BC; Rafeef Abugharbieh, BC

Purpose: Ultrasound (US) is the standard imaging modality used to screen for developmental dysplasia of the hip in infants. Currently, radiologists or orthopaedic surgeons review scan images and judge them to be adequate or inadequate for interpretation. If considered adequate, diagnostic dysplasia metrics
are determined; however, there is no standardized method for this process. There is significant inter-
observer variability in this manual process which can affect misdiagnosis rates. To eliminate this
subjectivity, we developed an automatic method to identify adequate US images and extract dysplasia
metrics. The purpose of this study was to validate the efficacy of this automatic method by comparing
results with observer-determined dysplasia metrics on a set of US images.

**Method:** A total of 693 US images from scans of 35 infants were analyzed. Trained clinicians at a single
institution labeled each image as adequate or inadequate, and subsequently measured alpha and beta
angles on adequate images to diagnose dysplasia. We trained our image classifier on random sets of 415
images and used it to assess the remaining 278 images. Alpha and beta angles were automatically
estimated on all adequate images. We compared the manual and automatic methods for discrepancies
in adequacy determination, metric variability and incidences of missed early diagnosis or over-
treatment.

**Results:** There was excellent agreement between the automatic and manual methods in image
adequacy classification (Kappa coefficient =0.912). On each adequate US image, alpha and beta angle
measurements were compared, producing mixed levels of agreement between methods. Mean
discrepancies of 1.78°±4.72° and 8.91°±6.437° were seen for alpha and beta angles, respectively.
Standard deviations of the angle measures across multiple images from a single patient scan were
significantly reduced by the automatic method for both alpha (p<0.05) and beta (p<0.01) angles.
Additionally, the automatic method classified three hips (two patients) as Graf type II and two hips (two
patients) as type III, while the manual method classified them as type I and II, respectively. Both cases
flagged as type III patients by the automatic system subsequently failed Pavlik harness treatment and
were booked for surgery.

**Conclusion:** The automatic method produced excellent agreement with radiologists in scan adequacy
classification and significantly reduced measurement variability. Good agreement between methods was
found in Graf classification. In instances of disagreement, subsequent clinical findings seemed to support
the classification of the automatic method. This proposed method presents an alternative automatic,
near-real-time analysis for US images that may potentially significantly improve dysplasia metric
reliability and reduce missed early diagnoses without increasing over-treatment.

147 - Results of Acute Ulnar Lengthening for Forearm Deformity in Hereditary Multiple Exostoses
Lisa Phillips, ON; Alex Aarvold, other; Sasha Carsen, ON; Christine Alvarez, BC

**Purpose:** Forearm deformity is common in Hereditary Multiple Exostoses, for which multiple surgical
treatments exist. Acute ulnar lengthening has been described in the literature, though in small numbers
and not independent of adjunctive procedures. We hypothesize that acute ulnar lengthening as a
primary procedure is safe and effective in correcting forearm deformity.

**Method:** Seventeen ulnas in 13 patients had acute ulnar lengthening for HME associated forearm
deformity, over an eight-year period. Radiographic parameters were assessed and compared
preoperatively and postoperatively. Mean follow-up was 27 months. Complications and revisions were
noted.
Results: The mean pre-operative ulnar variance, 12.4mm (range 6.1 – 16.5), was significantly reduced post-operatively to a mean 4.6mm (p<0.00001). A significant acute difference was achieved in carpal slip, (mean change of -2.2mm, p=0.02) but no significant change was seen with regard to radial bowing (p=0.98) or radial articular angle (p=0.74). There were three episodes of recurrence requiring revision. There were no major complications.

Conclusion: Significant radiographic improvements in forearm and wrist alignment were seen with acute ulnar lengthening. Complications were infrequent. Recurrence rates in the skeletally immature patients are comparable to that reported with gradual lengthening techniques. Acute ulnar lengthening for forearm deformity associated with HME, has been demonstrated to be a safe, reproducible and effective surgical procedure.
Validation of a Novel Classification System for Distal Ulna Fractures Associated with Distal Radius Fractures
Laura A Sims, SK; Geoffrey H Johnston, SK; Samuel A Stewart, NS

**Purpose:** Distal ulna fractures (DUF) are commonly associated with distal radius fractures (DRF). Recent evidence suggests that the presence and type DUFs may impact the outcomes of associated healing distal radius fractures. There is currently no standardized and validated classification system for characterizing distal ulna fractures. The purpose of this study was to assess the validity of our newly created inclusive classification system for distal ulna fractures, shown to influence distal radius fracture outcomes in a previous study.

**Method:** A classification system for distal ulna fractures was devised based on fracture pattern and location. Type 1 fractures were those in the ulnar styloid, with type 1a involving its apex and Type 1b being in the body of the styloid; Type 2 fractures are proximal to the styloid and involve the ulnar fovea, with type 2t adopting a transverse pattern and type 2o an oblique pattern; Type 3 fractures involve the ulnar head; and type 4 fractures were those proximal to the head, with 4n being through the neck (including the physeal scar) and 4s involving the distal shaft. A questionnaire was distributed to all members of the Canadian Orthopaedics Association in both French and English, asking participants to evaluate 29 radiographic images of distal ulnar fractures. Only one answer was deemed to be correct for all but one radiograph, while for one radiograph there were three fracture types to be identified.

**Results:** There were 129 respondents to the questionnaire. For Type 1a fractures, of the 606 radiographs evaluated 90% answered correctly and 73% of the incorrect answers identified a Type 1b fracture pattern. For Type 1b fractures, of 600 radiographs, 83% were answered correctly, the incorrect answers including Types 1a and 2t fracture types. For Type 2t fractures, of 593 radiographs, 76% were answered correctly, and 90% of the incorrect answers identified a Type 1b fracture pattern. For Type 2o fractures, of 716 radiographs, 87% were answered correctly, and 91% of the incorrect answers were identified as either Type 4n or 2t. For Type 4n fractures, of the 465 radiographs evaluated 84% answered correctly and 80% of the incorrect answers identified a Type 4s fracture pattern. For Type 4s fractures, of the 355 radiographs evaluated 99% answered correctly and 100% of the incorrect answers identified a Type 4n fracture pattern. The results will guide the authors to further distinguish between the definitions of Types 1b and 2t, and 4n and 4s.

**Conclusion:** The Canadian orthopaedic community has demonstrated how readily they can reproduce this new classification system, previously shown to be predictive of radiographic outcomes for the associated distal radius fractures. This new classification is an inclusive and simple way of characterizing these fractures with high reliability. This provides treating physicians with a uniform way of describing these fractures, useful both in predicting outcomes and conducting future research.

Phenol Embalming: A New Model for the Biomechanical Study of Flexor Tendon Repair
Sebastien Lalonde, ON; David Pichora, ON; Sima Zakani, ON
**Purpose:** Cadaveric specimens that have been fresh-frozen and then thawed for use have historically been considered to be the gold standard for biomechanical studies and the closest surrogate to living tissue. However, there are notable issues related to specimen rapid decay in the thawed state as well as infectious hazard to those handling the specimens. Cadaveric specimen preparation using a new phenol-based soft-embalmed method has shown considerable promise in preserving tissue in a prolonged fresh-like state while mitigating the infection risk. In this study, we evaluated the ability of soft-embalmed specimens to replace fresh-frozen specimens in the biomechanical study of flexor tendon repair.

**Method:** An ex-vivo study was conducted on six cadaveric hands in both a fresh-frozen, thawed state and following embalming with a phenol-based solution. Six different combinations of flexor digitorum profundus (FDP) tendons, from D2 to D5, and flexor pollicis longus (FPL) tendons were used to create two groups of similar composition with 15 tendons each, one group to be tested fresh and the other following embalming. A 5cm length of each flexor tendon was harvested from zone 2 and transversely cut at the mid-section. A modified-Kessler repair was performed on each specimen using 4-0 Fiberwire, with two core sutures and 1cm purchase on each end. Incisions were closed with a running stitch to prepare the specimen for embalming. The same protocol was used to repair and harvest the second group of tendons one month following the perfusion of a phenol-based solution through the vasculature of the hand and forearm. Tendon repair biomechanics were characterized through a ramp loading to failure (rate 1mm/sec), incorporating the 12 mm travel distance of the testing machine. A video-extensometry technique was used to validate machine recordings for the repair site for force at the 2mm gap distance, the ultimate strength, and the mode of failure. Characteristics of the two groups were tested for equivalency using inferential confidence intervals (ICI).

**Results:** Both fresh and embalmed groups were indistinguishable in both force at 2mm gap (fresh 17.9±4.7N; embalmed 18.1±5.1) and ultimate strength (fresh 43.93±10.0; embalmed 43.7±9.4) . With the exception of one specimen with complete suture pull-out, all specimens exhibited partial pull-out as the final mode of failure.

**Conclusion:** Our study demonstrated that tendon repair characteristics of phenol-embalmed specimens were equivalent to fresh specimens. Post-mortem chemical preservation can indeed preserve both visual and biomechanical characteristics of soft tissues. This study opens new avenues in support of the use of embalmed specimens in medical curricula and surgical training.

**150 - Restoring Hand Intrinsic Motor Function: Cadaver Study of Feasibility of in situ Sensory Branch of Radial Nerve as a Bridge Graft**

Kamran Mozaffarian, Iran; Hamid Reza Zemoodeh, Iran; Mohammad Zarenezhad, Iran; Mohammad Owji, Iran

**Comments:** Affiliation: Shiraz University of Medical Sciences, Bone and Joint Diseases Research Center

**Purpose:** In combined high median and ulnar nerve injury, transfer of extensor digiti minimi (EDM) and extensor carpi ulnaris (ECU) nerve branches to restore intrinsic hand function is previously described. A segment of nerve graft is required in this operation. The aim of this study was to evaluate the feasibility
of using the sensory branch of radial nerve (SRN) as an “in situ vascular nerve bridge” (IVNB) instead of sural nerve graft.

**Method:** Twenty fresh cadavers were dissected. In proximal forearm incision, the feasibility of transferring the EDM/ECU branches to the distal stump of transected SRN was evaluated. In distal forearm incision, the two distal branches of the SRN were transected near the radial styloid process to determine whether transfer of the proximal stumps of these branches to the motor branches of the median (MMN) and ulnar (MUN) nerves is possible. The number of axons in each nerve was determined.

**Results:** The size of the dissected nerves and their location demonstrate that tension free nerve coaptation is easily possible in both proximal and distal incisions.

**Conclusion:** Utilization of the SRN as an IVNB instead of the conventional sural nerve graft has some advantages. Firstly, the sural nerve graft is a single branch and could be sutured to either the MMN or MUN, whereas the SRN has two terminal branches and can address both of them. Secondly, the IVNB has live Schwann cells and may accelerate the regeneration. Finally, this IVNB does not require leg incision and could be performed under regional anesthesia. The SRN as an IVNB is a viable option which can be used instead of conventional nerve graft in some brachial plexus or high median and ulnar nerve injuries when restoration of intrinsic hand function by transfer of EDM/ECU branches is attempted.

**151 - Carpal Kinematics During Simulated Wrist Motion**

Helen L Stoesser, ON; Clare Padmore, ON; Masao Nishiwaki, Kawasaki; Braden Gammon, ON; G Daniel Langohr, ON; Emily Lalone, ON; James A Johnson, ON; Graham JW King, ON

**Purpose:** Wrist motion is achieved primarily via rotation at the radiocarpal and midcarpal joints. The contribution of each carpal bone to total range of motion has been previously investigated, although there is no consensus regarding the influence of each structure to global wrist motion. The objective of this comprehensive in-vitro biomechanical study was to determine the kinematics of the capitate, scaphoid and lunate during unconstrained simulated wrist flexion-extension. In addition, this study examined the effect of motion direction (i.e. flexion or extension) on the kinematics and contribution of the carpal bones.

**Method:** Seven fresh frozen cadaveric upper limb specimens (age: 67±18 yrs) were amputated mid-humerus, and the wrist flexors/extensors were exposed and sutured at their musculotendinous junctions. Each specimen was mounted on a wrist motion simulator in neutral forearm rotation with the elbow at 90° flexion. Passive flexion and extension motion of the wrist was simulated by moving a K-wire, inserted into the third metacarpal, through the flexion/extension motion arc at a speed of ~5 mm/sec under muscle tone loads of 10N. Carpal kinematics were captured using optical tracking of bone fixated markers. Kinematic data was analyzed from ±35° flexion/extension.

**Results:** Scaphoid and lunate motion differed between wrist flexion and extension, but correlated linearly (R²=0.99,0.97) with capitate motion. In wrist extension, the scaphoid (p=0.03) and lunate (p=0.01) extended 83±19% & 37±18% respectively relative to the capitate. In wrist flexion, the scaphoid (p=1.0) and lunate (p=0.01) flexed 95±20% and 70±12% respectively relative to the capitate. The ratio of
Carpal rotation to global wrist rotation decreased as the wrist moved from flexion to extension. The lunate rotates on average 46±25% less than the capitate and 35±31% less than the scaphoid during global wrist motion (p=0.01). The scaphoid rotates on average 11±19% less than the capitate during wrist flexion and extension (p=0.07). There was no difference in the contribution of carpal bone motion to global wrist motion during flexion (p=0.26) or extension (p=0.78).

Conclusion: The capitate, lunate and scaphoid move synergistically throughout planar motions of the wrist. Our study found that both the scaphoid and lunate contributed at a greater degree during wrist flexion compared to extension, suggesting that the radiocarpal joint plays a more critical role in wrist flexion. Our results agree with previous studies demonstrating that the scaphoid and lunate do not contribute equally to wrist motion and do not function as a single unit during planar wrist motion. The large magnitude of differential rotation observed between the scaphoid and lunate may be responsible for the high incidence of scapholunate ligament injuries relative to other intercarpal ligaments. An understanding of normal carpal kinematics may assist in developing more durable wrist arthroplasty designs.

152 - The Effect of Distal Radius Deformities on Wrist Kinematics - An in vitro Biomechanical Study
Clare E Padmore, ON; Helen Stoesser, ON; Masao Nishiwaki, Japan; Braden Gammon, ON; Dan Langohr, ON; Emily Lalone, ON; James Johnson, ON; Graham King, ON

Purpose: Distal radius fractures are the most common fracture of the upper extremity. Malunion of the distal radius is a common clinical problem after these injuries and frequently leads to pain, stiffness loss of strength and functional impairments. Currently, there is no consensus as to whether not the mal-aligned distal radius has an effect on carpal kinematics of the wrist. The purpose of this study was to examine the effect of dorsal angulation (DA) of the distal radius on midcarpal and radiocarpal joint kinematics, and their contributions to total wrist motion.

Method: A passive wrist motion simulator was used to test six fresh-frozen cadaveric upper extremities (age: 67 ± 17yrs). The specimens were amputated at mid humerus, leaving all wrist flexor and extensor tendons and ligamentous structures intact. Tone loads were applied to the wrist flexor and extensor tendons by pneumatic actuators via stainless steel cables. A previously developed distal radius implant was used to simulate native alignment and three DA deformity scenarios (DA 10 deg, 20 deg, and 30 deg). Specimens were rigidly mounted into the simulator with the elbow at 90 degrees of flexion, and guided through a full range of flexion and extension passive motion trials (~5deg/sec).Carpal motion was captured using optical tracking; radiolunate and capitulunate joint motion was measured and evaluated.

Results: For the normally aligned radius, radiolunate joint motion predominated in flexion, contributing on average 65.4% (±3.4). While the capitulunate joint motion predominated in extension, contributing on 63.8% (±14.0). Increasing DA resulted in significant alterations in radiolunate and capitulunate joint kinematics (p<0.001). There was a reduction of contribution from the capitulunate joint to total wrist motion throughout flexion-extension, significant from 5 degrees of wrist extension to full extension (p = 0.024). Conversely, the radiolunate joint increased its contribution to motion with increasing DA; significant from 5 degrees of wrist extension to full extension as the radiolunate and capitulunate joint
kinematics mirrored each other. A DA of 30 degrees resulted in an average radiolunate contribution of 72.6% ± 7.7, across the range of motion of 40 degrees of flexion to 25 degrees of extension.

**Conclusion:** The results of our study for the radius in a normal anatomic alignment are consistent with prior investigators, showing the radiocarpal joint dominated flexion, and the midcarpal joint dominated extension; with an average 60/40 division in contributions for the radiocarpal in flexion and the midcarpal in extension, respectfully. As DA increased, the radiocarpal joint provided a larger contribution of motion throughout flexion and extension. This alteration in carpal kinematics with increased distal radius dorsal angulation may increase localized stresses and perhaps lead to accelerated joint wear and wrist pain in patients with malunited distal radial fractures.

**153 - The Effect of Muscle Loading and Forearm Rotation on Distal Radioulnar Joint Cartilage Contact Mechanics**

**Emily Lalone, ON; Braden Gammon, ON; Ryan Willing, US; Masao Nishiwaki, Japan; James Johnson, ON; Graham King, ON**

**Purpose:** Altered distal radioulnar joint contact (DRUJ) mechanics are thought to cause degenerative changes in the joint following injury. Much of the current research examining DRUJ arthrokinematics focuses on the effect of joint malalignment and resultant degenerative changes. Little is known regarding native cartilage contact mechanics in the distal radioulnar joint. Moreover, current techniques used to measure joint contact rely on invasive procedures and are limited to statically loaded positions. The purpose of this study was to examine native distal radioulnar joint contact mechanics during simulated active and passive forearm rotation using a non-invasive imaging approach.

**Method:** Testing was performed using 8 fresh frozen cadaveric specimens (6 men: 2 women, mean age 62 years) with no CT evidence of osteoarthritis. The specimens were thawed and surgically prepared for biomechanical testing by isolating the tendons of relevant muscles involved in forearm rotation. The humerus was then rigidly secured to a wrist simulator allowing for simulated active and passive forearm rotation. Three-dimensional (3D) cartilage surface reconstructions of the distal radius and ulna were created using volumetric data acquired from computed tomography after joint disarticulation. Using optically tracked motion data and 3D surface reconstructions, the relative position of the cartilage models was rendered and used to measure DRUJ cartilage contact mechanics.

**Results:** The results of this study indicate that contact area was maximal in the DRUJ at 10 degrees of supination (p=0.002). There was more contact area in supination than pronation for both active (p=0.005) and passive (p=0.027) forearm rotation. There was no statistically significant difference in the size of the DRUJ contact patch when comparing analogous rotation angles for simulated active and passive forearm motion (p=0.55). The contact centroid moved 10.5±2.6 mm volar along the volar-dorsal axis during simulated active supination. Along the proximal-distal axis, the contact centroid moved 5.7±2.4 mm proximal during simulated active supination.

**Conclusion:** Using the technique employed in this study, it was possible to non-invasively examine joint cartilage contact mechanics of the distal radioulnar joint while undergoing simulated, continuous active and passive forearm rotation. Overall, there were higher contact area values in supination compared
with pronation, with a peak at 10 degrees of supination. The contact centroid moved volarly and proximally with supination. There was no difference in the measured cartilage contact area when comparing active and passive forearm rotation. This study gives new insight into the changes in contact patterns at the native distal radioulnar joint during simulated forearm rotation, and has implications for increasing our understanding of altered joint contact mechanics in the setting of deformity.

154 - Patient-reported Pain and Disability 10-years after a Distal Radius Fracture: A Prospective Study
Emily A Lalone, ON; Ruby Grewal, ON; Graham King, ON; Joy MacDermid, ON

Purpose: Long term outcomes of distal radius fractures have rarely been studied prospectively and do not traditionally extend past 1-2 years following treatment. The purpose of this study was to describe the long term patient-rated pain and disability of patients after a distal radius fracture and to also determine the differences in patient reported pain and disability after one year following injury and at the long term follow-up.

Method: Patients who had previously participated in a prospective study, where baseline and standardized one year follow-up were performed following a distal radius fracture were contact to participate in this long term follow-up (LTFU) study. Eligible cases that consented agreed to evaluation which included being sent a package in the mail contain a letter of information and questionnaire. Baseline demographic data including age and sex, as well as date of fracture, mechanism of fall and attending physician information was obtained for all participating subjects. Patient rated pain and disability was measured at baseline, one year and at long-term follow-up using the Patient Rated Wrist Evaluation (PRWE). Patients were categorized as having had a worse outcome (compared to one year follow-up PRWE scores) if their LTFU PRWE score increased by 5 points, having no change in status (if their score changed by four or less points) or improved if their LTFU PRWE score decreased by 5 or more points.

Results: Sixty-five patients (17 male, 48 female) with an average age of 57 years at the time of injury and 67 years at follow-up were included in the study. The mean length of follow-up was 10.7 (± 5.8) years (range: 3-19 years). Overall, 85% of patients reported having no change or had less patient-reported pain and disability (PRWE) at their long-term follow-up compared to their one year PRWE scores. As well, one year PRWE scores were found to be predictive (20.2%) of the variability in long term PRWE score (p=0.001).

Conclusion: This study provided data on a cohort of prospectively followed patients with a distal radius fracture, approximately 10 years after injury. This data may be useful to clinicians and therapists who are interested in determining the long term effects of this frequently occurring upper extremity fracture. The results of this study indicate that after 10 years following a distal radius fracture, 85% of patients will have good outcomes. The results of this study also indicate that majority of cases, if patients have a low amount of pain and disability at one year, then these outcomes will also be true approximately 10 years later.

155 - Clinical and Neurophysiological Results of the Supercharged End-to-Side Anterior Interosseous to Ulnar Motor Nerve Transfer in Severe Cubital Tunnel Syndrome
Mathilde Hupin, QC; Mami Okada, BC; Parham Daneshvar, BC

**Purpose:** Supercharged end-to-side nerve transfer for severe cubital tunnel syndrome is a recently developed technique which involves augmenting the ulnar motor branch with anterior interosseous nerve (AIN). Previous studies suggested that this technique augments or “babysits” the motor end plates until reinnervation occurs, however, some authors suggested possible reinnervation by the donor nerve. We present two cases where this transfer was done for rapid progressive (6-9 months) cubital tunnel syndrome.

**Method:** Case report

**Results:** The first case was a 57 year-old right hand dominant female who presented to us with severe right cubital tunnel syndrome clinically, including intrinsic wasting and claw deformity. The patient had significant loss of function and visible atrophy to her hand intrinsics over the last few months. Electrodiagnostic studies confirmed the diagnosis of severe cubital tunnel syndrome demonstrating axonal loss, positive sharp waves and fibrillations in the ulnar nerve distribution distally. The patient underwent cubital tunnel ulnar nerve release, subcutaneous anterior transposition, Guyon’s canal release along with an AIN to ulnar motor nerve end-to-side transfer. Patient-based functional outcome instruments were prospectively collected with improved overall pain and function as demonstrated from a quickDASH score of 9.1 1 year post-op in comparison to a score of 34.1 pre-op. Recovery was monitored clinically and electrodiagnostic studies at 6 months and 1 year post-operatively. She demonstrated improved intrinsic muscle bulk and strength. The nerve studies at one year showed reinnervation with large amplitude motor unit potentials in the 1st dorsal interosseous and abductor digitii minimi but the 5th finger sensory response remained absent. The second case was a 58 year-old right hand dominant male diagnosed with severe and progressive right cubital tunnel syndrome. Clinically, he had significant muscle wasting and weakness and confirmed denervation on electrodiagnostic studies. He underwent the same surgical procedure as described for the first case and follow-up regimen. The patient demonstrated improved pain score and significant overall function recovery with a quickDASH score of 11.4 one year post-op in comparison to 72.7 pre-op. Nerve studies at one year confirmed our clinical impression, showing ulnar nerve reinnervation with large amplitude motor unit potentials in the 1st dorsal interosseous, while sensory response remained absent.

**Conclusion:** It is yet unclear if end-to-side nerve transfers allow reinnervation of the target muscles. Previous studies have demonstrated clinical improvement with this transfer, however we are unaware of any electrodiagnostic studies demonstrating this effect. These two cases support the notion of reinnervation after an end-to-side procedure. Further studies are needed to assess outcomes of such nerve transfers.

156 - Temporal Patterns of Loss of Radial Height, Length and Tilt in Distal Radius Fractures in Women 50 Years and Older

Mark Abou-Ghaida, AB; Geoff Johnston, SK; Samuel A Stewart, NS

**Purpose:** Displaced distal radial fractures in adults are commonplace. Acknowledging that satisfactory radiographic parameters typically will beget satisfactory functional outcomes, management of these
fractures includes a reduction followed by either cast/splint immobilization or internal fixation. While we can generally rely on internal fixation to maintain the reduction the same is not true of cast immobilization. There are, however, limited data defining the fate of a fracture reduction in those treated in a cast and up to the time of radial union. Traditional practice is to recommend six weeks of immobilization. Our goal was to detail the radiographic patterns of change in the radiographic parameters of radial inclination (RI), ulnar variance (UV) and radial tilt (RT) over the first twelve weeks in women fifty years old and older who had sustained a displaced distal radial fracture.

**Method:** We examined serial standard PA and lateral distal radius radiographs of 647 women treated by closed reduction and casting for a displaced fracture of the distal radius. Measurements of RI, UV and RT from standardized radiographs were made immediately post-reduction as well as, as often as possible/feasible, at 1,2,3,6,9 and 12 weeks post fracture. All measurements were made by the senior author (accuracy range: 2 degrees for RI, 1 mm for UV and 4 degrees for RT, in 75% of cases). The primary outcome measure was the change in fracture position over time. Secondary outcomes included changes related to age group; known bone density; the relation to associated ulnar fractures; and independence of the variables of RI, UV and RT.

**Results:** The mean immediate post-reduction values for RI, UV and RT were 21 degrees, 1.5 mm, and -6 degrees, respectively. These all changed in the first six weeks, and did not in the second six week period. The mean change in RI was 3 degrees, 60% of the change occurring in the first week post-reduction; only 0.3 degrees of change was noted beyond three weeks. The mean UV increased by 2.2 mm over the first 6 weeks, 23% in the first week post reduction. The mean RT change of 7.7 degrees was also gradual over the first 6 weeks, with no significant change afterwards. The RI changes identified were not influenced by patient age, while UV and RT changes were greater in older groups. Those fractures of the distal radius associated with a distal ulnar shaft or neck fracture did not lose radial inclination over the study period.

**Conclusion:** We have defined patterns of loss of reduction that commonly occur post reduction of a displaced distal radius fracture in women fifty years and older. Such patterns ought to guide our closed management of distal radial fractures, whether by altering the duration or method of casting. Women fifty years old and older, and physicians alike, must be advised that conventional casting post distal radial fracture reduction unreliably maintains fracture reduction.
160 - Metal and Cement Hypersensitivity in Painful Total Knee Arthroplasty. Screening using Lymphocyte Transformation Test
Andréea Senay, QC; Mohamed Benderdour, QC; G Yves Laflamme, QC; Pierre Ranger, QC; Qin Shi, QC; Josée Delisle, QC; Julio Fernandes, QC

Purpose: Total joint arthroplasty has proven to be efficient to relieve pain and regain mobility. In fact, most patients undergoing a total knee arthroplasty (TKA) are satisfied with their surgery (80 to 90%), yet 4 to 7% still complain of unexplainable pain and stiffness. Several authors have proposed that reactivity to the implant could explain this phenomenon. Still, no strong evidence supports this theory as of today. We aimed to determine the prevalence of metal and cement hypersensitivity in a cohort of patients with unexplained pain and stiffness after TKA.

Method: We retrieved data for a group of patients presenting unexplained pain and stiffness. We excluded all other potential known causes of pain. All patients were tested with a Lymphocyte Transformation Test from whole blood taps. We analyzed data of hypersensitivity to metals (alloy particles of titanium and cobalt, aluminum, cobalt, nickel, zirconium, vanadium, molybdenum, cobalt, chromium and iron) and PMMA cement (bone cement monomer and particles).

Results: Fifty-three patients underwent a LTT for unexplained pain and stiffness after total knee arthroplasty between May 2012 and May 2015. The cohort consisted of 26 men and 27 women with a mean age of 66.3(±8.0) years. Six patients had no hypersensitivity (11.3%), leaving 88.7% of the cohort with hypersensitivity to metal and/or cement. Almost half the cohort of patients tested for PMMA was hypersensitive to cement (44.0%). The most common metal hypersensitivity was nickel (69.8%). Twelve patients presented sensitivity to only one metal (22.6%), whereas 35 patients were hypersensitive to more than one metal (66.0%). Eleven patients had revision surgery with a hypoallergenic prosthesis. Patients reported a significant diminution of pain as well as better knee function compared to preoperative status as early as 6 weeks postop, although some reported residual stiffness.

Conclusion: The results of this study suggest that metal and/or cement hypersensitivity could play a role in cases of total knee arthroplasty with unexplained pain and stiffness. Randomized controlled clinical trials on the subject will be initiated by our team to further investigate this phenomenon.

161 - No Beneficial Effects with Whole-course Tourniquet and Closed-Suction Drain Use on Bleeding Management, Knee Function and Related Costs in Total Knee Arthroplasty
David Yin, QC; Jiang Jun, QC; Josée Delisle, QC; Andreea Banica, QC; Andréea Senay, QC; G Yves Laflamme, QC; Pierre Ranger, QC; Julio C Fernandes, QC

Purpose: Blood loss is a major concern in total knee arthroplasty (TKA) along with postoperative knee function. The present study explores the impact of tourniquet and closed-suction drains on blood loss as well as knee function in TKA.

Method: A prospective clinical trial was conducted on 111 patients admitted for TKA. Subjects were divided into three groups based on duration of tourniquet use (T+: whole-course tourniquet, T-:
cementation only tourniquet) and usage of closed-suction drain (D+: drain use, D-: no drain). Thirty-six subjects were included in group T+D+, 42 in T-D+ and 33 in T-D-. Data from study population was analyzed for pre and post-operative hemoglobin level (Hb), perioperative and total blood loss, blood transfusion rates, knee range of motion (ROM), and pain level assessment. Direct and indirect costs associated to nursing time and drains were calculated. Results are presented in mean ± SD.

Results: No statistically significant differences were observed among the three groups (T+D+, T-D+ and T-D-) concerning total blood lost (calculated using Gross’ formula), Hb levels over the first six postoperative weeks, blood transfusion rates and intra-articular hematomas. Intraoperative bleeding was significantly reduced in T+ subjects compared to T- subjects (100 ± 88 mL vs. 279 ± 235 mL respectively, p < 0.001), yet length of surgery was unaffected by the different tourniquet inflation strategies. Hidden blood loss was lower in D+ subjects compared to D- subjects (1161 ± 554 mL vs. 1667 ± 554 mL respectively, p < 0.001), but it was compensated by the blood loss in the drains. Early postoperative ROM (flexion: 79.1 ± 14.8°, extension: -5.0 ± 6.7°) was superior in group T-D+ compared to group T+D+ (flexion: 71.9 ± 17.1°, p = 0.071°; extension: -9.9 ± 6.4°, p = 0.004). Nevertheless, ROM six weeks postoperative was not statistically different between groups (flexion: 114.0 ± 13.3°, extension: 0.4 ± 5.2°). Patient-reported postoperative pain was also similar in all groups. Nursing time dedicated to drain management was 30 min/patient (330h total for 660 patients/year). Total costs related to drains were $31.92CAD/patient ($21,067CAD total for 660 patients/year).

Conclusion: Our results suggest that whole-course tourniquet and closed-suction drain use in TKA do not yield beneficial results in total blood loss, blood transfusion rates, complication rates and knee rehabilitation. Their clinical relevance in TKA is questionable. Moreover, nursing time and costs related to drains should have been allocated elsewhere in patient care.

162 - Migration of a Titanium, Fixed-bearing, Polished Tibial Baseplate at 10 Years Measured with Radiostereometric Analysis

Brent Lanting, ON; Jacalyn Thoren, ON; Xunhua Yuan, ON; Richard McCalden, ON; James McAuley, ON; Steven MacDonald, ON; Edward Vasarhelyi, ON; James Howard, ON; Douglas Naudie, ON; Matthew Teeter, ON

Purpose: Adequate fixation of implant components is an important goal for all arthroplasty procedures. Aseptic loosening is one of the leading causes of revision surgery in total knee arthroplasty. Radiostereometric analysis (RSA) is an imaging technique to measure implant migration, with established migration thresholds for well-fixed, at risk, and unacceptably migrating components. The purpose of the present study was to examine the long-term fixation of a cemented titanium fixed bearing polished tibial baseplate.

Method: Patients enrolled in a previous two-year prospective trial were recalled at ten years. All patients received a cemented, posterior-stabilized total knee replacement of the same design implanted by one of three surgeons. Of the original 35 patients, 16 were available for long-term follow-up, with one patient lost to follow-up, nine patients deceased, and a further nine patients unwilling to return to the clinic. Each patient underwent RSA imaging in a supine position using a conventional RSA protocol. Migration of the tibial component in all planes as well as maximum total point motion (MTPM) was
compared between all time points (baseline, six weeks, three months, six months, one year, two years) up to the ten year follow-up visits. Outcome scores including the Knee Society Score (KSS), WOMAC, SF-12, and UCLA Activity Score were recorded.

Results: At ten years, the mean migrations of the tibial component were less than 0.1 mm and 0.1 degree in all planes relative to the post-operative RSA exam. There was no significant difference in tibial component migration between time points. However, MTPM increased significantly over time ($p = 0.002$), from $0.23 \pm 0.18$ mm at six weeks to $0.42 \pm 0.20$ mm at ten years. At one year, 13 patients had an acceptable MTPM level, three patients had an ‘at risk’ level, and no patient had an ‘unacceptable’ level. No patients were revised at ten years. WOMAC and KSS were significantly improved ($p < 0.0001$) at the latest follow-up compared to pre-operatively, but there was no difference in SF-12. The median UCLA Activity Score at latest follow-up was six (range, two to eight).

Conclusion: The tibial baseplate demonstrated solid fixation at ten years. No patients had an unacceptable MTPM level at one year and no patients were revised at ten years, supporting the use of RSA to predict long-term loosening risk. The low level of tibial baseplate migration found in the present study correlates to the low rate of revision for this implant as reported in individual studies and in joint replacement registries.

163 - Lucent Lines: Relevance Under the Tibial Component
Herman S Dhotar, ON; Farid Guirgis, ON; David Backstein, ON

Purpose: Recent analyses of failure mechanisms continue to show aseptic loosening as the predominant mechanism of total knee arthroplasty (TKA) failure. Evaluation for aseptic loosening begins with careful assessment of plain films radiographs, however the utility of examining lucent lines under a cemented tibial tray remains unclear. The purpose of this study is to examine the distribution of lucent lines under cemented tibial components on single-series anteroposterior (AP) and lateral plain radiographs and to determine their significance in the prediction of aseptic loosening found during revision TKA surgery.

Method: Retrospective chart and radiographic review of all patients that underwent revision TKA between 2001-2014 at a single academic hospital center. Revision TKA for periprosthetic fracture, stem fracture, implant dissociation and periprosthetic joint infection were excluded. The most recent pre-revision surgery AP and lateral knee radiographs were assessed by two fellowship trained adult reconstruction surgeons blinded to patient demographics and intraoperative details. Lucent lines under the tibia tray defined as >2mm were documented according to the new KSS radiographic scoring system. Demographic details and the surgeon’s assessment whether the tibia tray was loose intraoperatively were extracted from chart review and the operative note, respectively. Univariate and multivariable logistic regression modeling was used to predict the outcome of aseptic loosening.

Results: Between 2001 and 2014, 312 revision TKAs were performed that met our inclusion criteria. Of these, 84 (26.9%) had intraoperative loose tibia trays. We observed a significantly increased risk of aseptic tibia loosening among older patients at time of surgery (odds ratio [OR] 1.05, 95% CI 1.02, 1.08). Posterior stabilized primary TKA components conferred a significantly decreased risk of aseptic tibia loosening (OR 0.36, 95% 0.21, 0.60). On an AP radiograph, after adjustment for other zones, the
presence of a lucent line in zone 1, 2 or 3 were all significantly associated with tibia loosening, OR 7.35, 8.69 and 22.26 (p<0.0001) respectively. On a lateral radiograph, after adjustment for other zones, the presence of a lucent line in zone 1, 2 or 3 were all significantly associated with tibia loosening, OR 12.89, 18.03, and 11.63 (p<0.004) respectively. The complete absence of lucent lines under a tibia tray on an AP or lateral radiograph were associated with 96% (CI 0.02, 0.07) and 95% (CI 0.02, 0.09) reduced odds of aseptic tibia loosening.

Conclusion: Careful examination of lucent lines under a tibia component can be highly predictive of aseptic loosening. The areas associated with highest risk of tibia loosening occur in zone 3 on the AP radiograph (medial or lateral to the keel) and zone 2 on the lateral radiograph (posteriorly). The risk of loosening in the absence of lucent line findings on plain films is significantly low.

164 - One Year Migration of Uncemented Monoblock and Modular Trabecular Metal Total Knee Replacements in an Randomized Controlled Trial
Elise Laende, NS; Michael Dunbar, NS; Glen Richardson, NS; Gerry Reardon, NS; David Amirault, NS

Purpose: The trabecular metal Monoblock TKR is comprised of a porous tantalum base plate with the polyethylene liner embedded directly in the porous metal. An alternative design, the trabecular metal Modular TKR, allows polyethylene liner insertion into the locking base plate after base plate implantation, but removes the low modulus of elasticity that was inherent in the Monoblock design. The purpose of this study was to compare the fixation of the Monoblock and Modular trabecular metal base plates in a randomized controlled trial.

Method: Fifty subjects (30 female) were randomly assigned to receive the uncemented trabecular metal Monoblock or uncemented trabecular metal Modular knee replacement. A standard procedure of tantalum marker insertion in the proximal tibial and polyethylene liner was followed with uniplanar radiostereometric analysis (RSA) examinations immediately post-operatively and at 6 week, 3 month, 6 month, and 12 month follow-ups. The study was approved by the Research Ethics Board and all subjects signed an Informed Consent Form.

Results: Twenty-one subjects received Monoblock components and 20 received Modular components. An intra-operative decision to use cemented implants occurred in 5 cases and 4 subjects did not proceed to surgery after enrollment. The clinical precision of implant migration measured as maximum total point motion (MTPM) was 0.13 mm (upper limit of 95% confidence interval of double exams). Implant migration at 12 months was 0.88 ± 0.64 mm (mean and standard deviation; range 0.21 – 2.84 mm) for the Monoblock group and 1.60 ± 1.51 mm (mean and standard deviation; range 0.27 – 6.23 mm) for the Modular group. Group differences in 12 month migration approached clinical significance (p = 0.052, Mann Whitney U-test).

Conclusion: High early implant migration is associated with an increased risk for late aseptic loosening. Although not statistically significant, the mean migration for the Modular component group was nearly twice that of the Monoblock, which places it at the 1.6 mm threshold for “unacceptable” early migration (Pijls et al 2012). This finding is concerning in light of the recent recall of a similar trabecular metal
modular knee replacement and adds validity to the use of RSA in the introduction of new or modified implant designs.


165 - Effectiveness of Valgus Braces for Knee Osteoarthritis Can be Predicted by Unbraced Static and Dynamic Measures

Elizabeth A Hassan, ON; Allison Tucker, ON; Allison Clouthier, ON; Kevin Deluzio, ON; Scott Brandon, ON; Michael Rainbow, ON

Purpose: Valgus knee unloader braces are often prescribed as treatment for knee osteoarthritis (OA). These braces are designed to redistribute the loading in the knee, thereby reducing medial contact forces. Patient response to bracing is variable; some patients experience improvements in joint loading, pain, and function, others see little to no effect. We hypothesized that patients who experienced beneficial response to the brace, measured by reductions in medial contact force, could be predicted based on static and dynamic measures.

Method: Participants completed a WOMAC questionnaire and walked overground with and without an OA Assist knee brace in a motion capture lab. Eighteen patients with medial compartment OA (8 female, 53.8±7.0 years, BMI 30.3±4.1, median Kellgren-Lawrence grade 4 (range 1-4)) were evaluated. The abduction moment applied by the brace was estimated by multiplying brace deflection by the predetermined brace stiffness. A generic musculoskeletal model was scaled for each participant based on standing full length radiographs and anatomical markers. Inverse kinematics, inverse dynamics, residual reduction, and muscle analysis were completed in OpenSim 3.2. A static optimization was then performed to estimate muscle forces and then tibiofemoral contact forces were calculated. Brace effectiveness was defined by the difference in the first peak of the medial contact force between braced and unbraced conditions. Principal component analysis was performed on the hip, knee, and ankle angles and moments from the unbraced walking condition to extract the principal component (PC) scores for these variables. A linear regression procedure was used to determine which variables related to brace effectiveness. Potential regressors included: hip-knee-ankle angle and medial joint space measured radiographically; KL grade; mass; WOMAC scores; unbraced walking speed; and the first two principal component scores for each of the unbraced hip, knee, and ankle joint angles and moments.

Results: KL grade, walking speed, and hip adduction moment PC1, which represented the magnitude of the first peak were all found to be correlated with change in medial contact force. The brace was more successful in reducing medial contact force in subjects with higher KL grades, faster self-selected walking speeds, and larger peak external hip adduction moments. The R2 value for the overall regression model was 0.78.

Conclusion: The best predictor of brace effectiveness was the hip adduction moment, indicating the need to consider dynamic measures. Participants who had hip adduction moments and walking speeds similar to those of their healthy counterparts saw a greater reduction in medial contact force. Thus, those who responded to bracing had more severe OA as measured by the KL grade but had not
experienced changes in their hip adduction moment due to OA. The results of this study suggest that there is potential for an objective criterion for valgus knee brace use to be established.

166 - Current Total Knee Designs: Effect of Baseplate Roughness and Locking Mechanism on Polyethylene Backside Wear

Zachary Sisko, ON; Matthew Teeter, ON; Brent Lanting, ON; James Howard, ON; Richard McCalden, ON; Douglas Naudie, ON; Steven MacDonald, ON; Edward Vasarhelyi, ON

Purpose: Previous retrieval studies demonstrate increased tibial baseplate roughness leads to higher polyethylene backside wear in total knee arthroplasty (TKA). Micromotion between the polyethylene backside and tibial baseplate is affected by the locking mechanism design and can further increase backside wear. The purpose of this study was to examine modern locking mechanisms, in the setting of both roughened and polished tibial baseplates, on backside tibial polyethylene wear.

Method: Five TKA models were selected, all with different tibial baseplate and/or locking mechanism designs. Six retrieval tibial polyethylenes from each TKA model were matched based on time in vivo (TIV), age at TKA revision, BMI, gender, number of times revised, and revision reason. Two observers scored each polyethylene backside according to a visual damage score and individual damage modes. Primary outcomes were mean damage score and individual damage modes. Demographics were compared by one-way ANOVA. Damage scores and modes were analyzed by the Kruskal-Wallis test and Dunn's multiple comparisons test.

Results: There were no differences among the groups based on TIV (p=0.962), age (p=0.651), BMI (p=0.951), gender, revision number, or reason for revision. There was a significant difference across groups for mean total damage score (p=0.029). The polished tibial design with a partial peripheral capture locking mechanism and anterior constraint demonstrated a significantly lower score compared to one of the roughened tibial designs with a complete peripheral-rim locking mechanism (13.0 vs. 22.1, p=0.018). Otherwise, mean total damage scores were not significant between groups. As far as modes of wear, there were identifiable differences among the groups based on abrasions (p=0.005). The polished design with a tongue-in-groove locking mechanism demonstrated a significantly higher score compared to both groups with roughened tibial baseplates (5.83 vs. 0.83, p=0.024 and 5.83 vs. 0.92, p=0.033). Only the two designs with roughened tibial baseplates demonstrated dimpling (5.67 and 8.67) which was significant when compared against all other groups (p<0.001). No other significant differences were identified when examining burnishing, cold flow, scratching, or pitting. No polyethylene components exhibited embedded debris or delamination.

Conclusion: Total damage scores were similar between all groups except when comparing one of the polished TKA design to one of the roughened designs. The other TKA model with a roughened tibial baseplate had similar damage scores to the polished designs, likely due to its updated locking mechanism. Dimpling wear patterns were specific for roughened tibial baseplates while abrasive wear patterns were identified in the design with a tongue-in-groove locking mechanism. Our study showed even in the setting of a roughened tibial baseplate, modern locking mechanisms decrease backside wear similar to that of other current generation TKA designs.
Impact of Training Level on Postoperative Complications in Total Knee Arthroplasties: US versus Canada

Mohammed Ahmed O Al Sobeai, QC; Laura M Epure, QC; Stephane Bergeron, QC; Olga Huk, QC; David Zukor, QC; John Antoniou, QC

Purpose: Utilizing the (ACS-NSQIP) database, we aimed to evaluate the impact of resident level of training on surgical outcome following (TKA) and to compare the US and Canadian health care training system in regards to 30 days postoperative complications and readmission rates.

Method: Using the (CPT) codes we selected from the 2011 and 2012 NSQIP database elective primary TKA with the resident surgeon involved. Of these, all cases with a primary diagnosis code of infection, fracture, mechanical complication, or malignancy and all cases with incomplete or incongruous demographic information were excluded. We also eliminated all the cases with the Attending not present. A total of 2513 cases were included in the study. The cases were stratified into three groups according to the postgraduate level of training {PGY 1 to 3 (junior resident), PGY 4 to 5 (senior resident), and fellow}. Univariate analysis of all patient demographics, comorbidities, intra and postoperative variables, length of surgery, hospital stay and 30 days readmission rates were conducted in order to identify differences between the groups. A standard student’s t test was used for continuous variables while the ChiSquared was used for categorical variables. Multivariable logistic regression models were created to assess the independent effect of the resident level of training on the 30 days major complication and readmission rates while controlling for all other variables.

Results: We identified, 854 (34%) TKAs with junior residents, 1013 (40%) TKAs with senior residents and 646 (26%) TKAs with fellows participation. Junior residents had a significant (p<0.0001) longer operative time (107±36 minutes) compared with senior residents and fellows. Length of hospital stay was longer in the fellow group probably because of their involvement in more complicated cases. Additionally, an increased number of blood transfusion was observed for the cases performed with involvement of senior residents when compared with the other two groups. However, no significant difference in complications was observed across training levels. When comparing US (2074 TKAs) versus Canada (423 TKAs) cases, we found that fellow contribution to TKA surgeries is higher in Canada. The occurrence of pulmonary embolism and pneumonia was three times higher in Canada cases, while blood transfusion was more frequent in US. Increased operative time, ASA class, age, diabetes, percutaneous cardiac intervention, and steroid use were all independent risk factors for complications following primary TKA. However, no significant difference was observed between the two groups with regards to major complications suggesting no difference between Canadian and American training system in regards to post operative complication.

Conclusion: Our results support previous study indicating that involvement of residents did not affect the surgical outcome within 30 days when compared to cases with no resident involvement. Our study suggests that resident level does not independently increase the risk of short term complications and support continuing involvement of junior trainees in TKA.

TKR Wear Measurement in 72 Patients Using Radiostereometric Analysis
**Trevor C Gascoyne, MB; Sara L Parashin, MB; Thomas R Turgeon, MB; Eric R Bohm, MB; Elise Laende, NS; Michael Dunbar, NS**

**Purpose:** Articulation of the polyethylene (PE) insert between the metal femoral and tibial components in total knee replacements (TKR) results in wear of the insert which can necessitate revision surgery. Continuous PE advancements have improved wear resistance and durability increasing implant longevity. Keeping up with these material advancements, this study utilizes model-based radiostereometric analysis (mbRSA) as a tool to measure in vivo short-term linear PE wear to thus predict long-term wear of the insert.

**Method:** Radiographic data was collected from the QEII Health Sciences Centre in Halifax, NS. Data consisted of follow-up RSA examinations at post-operative, six-, 12-, and 24-month time periods for 72 patients who received a TKR. Implanted in all patients were Stryker Triathlon TKRs with a fixed, conventional PE bearing of either a cruciate retaining or posterior stabilized design. Computer-aided design (CAD) implant models were either provided by the manufacturer or obtained from 3D scanned retrieved implants. Tibial and femoral CAD models were used in mbRSA to capture pose data in the form of Cartesian coordinates at all follow-ups for each patient. Coordinate data was manually entered into a 3D modeling software (Geomagic Studio) to position the implant components in virtual space as presented in the RSA examinations. PE wear was measured over successive follow-ups as the linear change in joint space, defined as the shortest distance between the tibial baseplate and femoral component, independently for medial and lateral sides. A linear best-fit was applied to each patient’s wear data; the slope of this line determined the annual wear rate per individual patient. Wear rates were averaged to provide a mean rate of in vivo wear for the Triathlon PE bearing.

**Results:** Mean linear wear per annum across all 72 patients was 0.088mm/yr (SD: 0.271 mm/yr) for the medial condyle and 0.032 mm/yr (SD: 0.230 mm/yr) for the lateral condyle. Cumulative linear wear at the 2-year follow-up interval was 0.207mm (SD: 0.565mm) and 0.068mm (SD: 0.484mm) for the medial and lateral condyles, respectively.

**Conclusion:** Linear PE wear measurements using mbRSA and Geomagic Studio resulted in 0.056mm/yr additional wear on the medial condyle than the lateral condyle. Large standard deviations for yearly wear rates and cumulative measurements demonstrate this method does not yet exhibit the accuracy needed to provide short-term in vivo wear measurement. Inter-patient variability from RSA examinations is likely a source of error when dealing with such small units of measure. Further analysis on patient age and body mass index may eliminate some variability in the data to improve accuracy. Despite high standard deviations, the results from this research are in proximity to previously reported linear wear measurements 0.052mm/yr and 0.054mm/yr. Linear wear analysis will continue upon completion of >100 patients, in addition to volumetric PE wear over the entire articulating surface.

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**169 - Constitutional Varus and the Relative Contribution of the Tibia and Femur to Frontal Plane Alignment in Varus Osteoarthritic Knees**

**Nicholas Matlovich, ON; Brent Lanting, ON; Steven MacDonald, ON; Matthew Teeter, ON; James Howard, ON**
**Purpose:** The concept of constitutional varus and controversy regarding placing the total knee arthroplasty (TKA) in a neutral versus physiologic alignment in varus osteoarthritic (OA) patients is an important current discussion. However, the physiologic mechanical alignment of a varus OA knee is unknown and the relative contribution of the femur and tibia to the mechanical axis is unknown. The goal of this study was to determine and analyze the physiologic mechanical axis of medial OA knees.

**Method:** Plain radiographs of the knee and full-leg standing radiographs of 1558 patients were reviewed for inclusion criteria; 313 patients with a non-arthritic knee and a contralateral varus end-stage OA knee were analyzed in the coronal plane. The Hip-Knee-Ankle (HKA), Condylar-Hip (CH)(femoral), Condylar-Plateau (CP) (intra-articular) and Plateau-Ankle (PA)(tibial) angles were measured for both thearthritic and non-arthritic/physiologic knee. The relationship and contribution of all angles was analyzed for every 2° degrees of progressive varus: from 4° valgus to 8° varus. The proportion of patients with constitutional varus was also determined for the sample population and correlated with increasing HKA.

**Results:** The mean CH (femoral) angle was valgus in all groups and decreased with progressive varus alignment (p< 0.0001), ranging from 3.8° ± 1.0° with HKA of 2-4° valgus, to 0.1° ± 1.5° with HKA of 6-8° varus. The mean PA (tibial) angle was varus in all groups and decreased from valgus to progressively varus alignment (p<0.0001), ranging from 0.78° ± 1.4° with HKA 2-4° valgus, to 5.6° ± 1.9° with HKA 6-8° varus. The CP angle showed no difference between all groups (p=0.3). Forty five percent of males and 22% of females with arthritic HKA in varus alignment were found to have constitutional varus.

**Conclusion:** Correlation of unilateral arthritic knees to the unaffected, physiologic aligned knee using full-leg radiographs indicates that it may be possible to understand the patient’s physiologic, pre-arthritic coronal plane alignment. The mechanical axis of physiologic knees in a unilateral varus OA population demonstrates a variable contribution of the femur (CH) and tibia (PA) from overall valgus to varus alignment. In addition, a significant proportion of the sample population possessed constitutional varus. This may provide important information regarding the placement of physiologic TKA’s and direct future research questions.
170 - Radial Tears of the Lateral Meniscus - Comparison of Three Repair Techniques using All-inside Devices
Jennifer Mutch, ON; Allison Cracchiolo, US; Patrick Keating, US; Stephen E Lemos, US

Purpose: Background: The absence of menisci in the knee leads to early degenerative changes. Complete radial tears of the meniscus are equivalent to total meniscectomy and repair should be performed if possible. Purpose: The purpose of this study was to biomechanically compare the cross suture, hashtag and crosstag meniscal repairs using all-inside implants for radial tears.

Method: Methods: Radial tears were created at the mid-body of 36 fresh-frozen lateral human menisci and then repaired, in randomized order, with Fast-Fix™ 360s (Smith & Nephew, Andover, MA) using the cross suture, hashtag and crosstag techniques. The repaired menisci were tested using an Instron Electropuls E10000 (Instron, Norwood, MA). The tests consisted of cyclic loading from 5 to 30N at 1Hz for 500 cycles, then a load to failure test. Displacement following cyclic loading, load at 3mm of displacement, load to failure, and stiffness were recorded. Any differences between repairs were assessed using Kruskal-Wallis and Mann Whitney tests (p<0.05).

Results: Cross suture repairs displaced more following cyclic loading and resisted less load to failure than both the hashtag and crosstag repairs. However, these differences were not statistically significant. The average displacement following cyclic loading of cross suture, hashtag, and crosstag repairs was 4.34 mm (±2.02 mm), 3.46 mm (±2.12 mm), and 3.24 mm (±1.52 mm) respectively (p=0.33). Maximal load to failure was 64.83 N (±17.41 N), 74.52 N (±9.03 N), and 74.98N (±10.50N), respectively (p=0.419).

Conclusion: All-inside cross suture, hashtag and crosstag repairs all displaced >3mm with cyclic loading, which is the threshold for meniscal insufficiency. This contrasts previous studies using inside-out sutures, where crosstag and hashtag repairs resisted cyclic loading (< 3mm). Inside-out suturing for radial tears of the lateral meniscus currently remains the gold standard.

171 - The Synergistic Role of the Lateral Meniscus Posterior Root and the ALL in Providing Anterolateral Rotational Stability of the Knee
Gillian Corbo, ON; Tim Lording, BC; Timothy Burkhart, ON; Alan Getgood, ON

Purpose: Injury to the anterolateral ligament (ALL) has been reported to contribute to high-grade anterolateral laxity following anterior cruciate ligament (ACL) injury. Failure to address ALL injury has been suggested as a cause of persistent rotational laxity following ACL reconstruction. However, lateral meniscus posterior root (LMPR) tears have also been shown to cause increased internal rotation and anterior translation of the knee. Due to the anatomic relationship of the ALL and the lateral meniscus, we hypothesize that the ALL and lateral meniscus work synergistically, and that a tear to the LMPR will have the same effect on anterolateral laxity as an ALL tear in the ACL deficient knee.

Method: Sixteen fresh frozen cadaveric knee specimens were potted into a hip simulator(femur) and a six degree-of-freedom load cell (tibia). Two rigid optical trackers were inserted into the proximal femur
and distal tibia, allowing for the motion of the tibia with respect to the femur to be tracked during biomechanical tests. A series of points on the femur and tibia were digitized to create bone coordinate systems that were used to calculate the kinematic variables. Biomechanical testing involved applying a 5Nm internal rotation moment to the tibia while the knee was in full extension and tested sequentially in the following three conditions: i) ACLintact; ii) Partial ACL injury (ACLam) -anteromedial bundle sectioned; iii) Full ACL injury (ACLfull). The specimens were then randomized to either have the ALL sectioned first (ALLsec) followed by the LMPRsec or vice versa. Internal rotation and anterior translation of the tibia with respect to the femur were calculated. A mixed two-way (serial sectioning by ALL section order) repeated measures ANOVA (alpha = 0.05).

Results: Compared to the ACLintact condition, internal rotation was found to be 1.78° (p=0.06), 3.74° (p=0.001), and 3.84° (p=0.001) greater following ACLfull, LMPRsec and ALLsec respectively. LMPRsec and the ALLsec resulted in approximately 20 of additional internal rotation (p=0.004 and p=0.01, respectively) compared with the ACL deficient knee (ACLfull). No difference was observed between the ALL and LMPR sectioned states, or whether the ALL was sectioned before or after the LMPR (p=0.160). A trend of increasing anterior translation was observed when the 5Nm internal rotation moment was applied up until the ACL was fully sectioned; however, these differences were not significant (p=0.070).

Conclusion: The ALL and LMPR seem to have a synergistic relationship in aiding the ACL in controlling anterolateral rotational laxity. High-grade anterolateral laxity following ACL injury may be attributed to injuries of the ALL and/or the LMPR. We suggest that the lateral meniscus should be thought of as part of the anterolateral capsulomeniscal complex (i.e., LM, ITB, and ALL) that acts as a stabilizer of anterolateral rotation in conjunction with the ACL.

172 - Factor Analysis and Item Reduction of the Banff Patellofemoral Instability Instrument: Introduction of the BPII 2.0

Sarah Kerslake, AB; Mark R Lafave, AB; Laurie A Hiemstra, AB

Purpose: Clinical management of patellofemoral (PF) instability is a challenge, particularly considering the wide range of contributing variables that must be taken into consideration when determining optimal treatment. An important outcome measure to consider in this patient population is disease-specific quality of life (QOL). The purpose of this study was to factor analyse and reduce the total number of items in the Banff Patellar Instability Instrument (BPII). Subsequent to the factor analysis, the new, item-reduced BPII 2.0 was tested for validity, reliability and responsiveness.

Method: Disease-specific QOL was measured in patients with a confirmed diagnosis of PF instability (n = 223) at the initial consultation with the original BPII. Data from these BPII scores was used to employ a principal component analysis (PCA) to factor analyse and reduce the total number of items in the original BPII, to create the new BPII 2.0. The BPII 2.0 underwent content validation (Cronbach’s Alpha, patient interviews and reading-level); construct validation (ANOVA comparing the initial consultation, 6, 12 and 24 month post-operative, Eta squared); convergent validation (Pearson r correlation to the original BPII); responsiveness testing (Eta squared, anchor-based distribution testing); and reliability testing (intra-class correlation coefficient (ICC) 2,k).
**Results:** The original BPII was successfully reduced from 32 to 23 items. The new BPII 2.0 demonstrated excellent Cronbach’s Alpha values: initial consult = 0.91; 6-months = 0.96; 12-months = 0.97; and 24-months post-operative = 0.76. Grade-level reading assessment for all items in the BPII 2.0 was below grade twelve. The ANOVA determined the BPII 2.0 was able to discriminate between the initial consultation, 6, 12 and 24 months post-operative assessments, with significant differences between each time-point (p < 0.05). Eta squared was 0.40, demonstrating a medium to large effect size. Convergent validity was established with the BPII 2.0 significantly correlated to the original BPII (initial consult = 0.82, 6-month = 0.90, 12-month = 0.90, and 24-month = 0.94). Anchor-based responsiveness was established with a significant correlation between the 7-point scale of patient-perceived improvement and 24-month post-operative BPII 2.0 scores. Strong reliability was established with an ICC (2,k) = .97.

**Conclusion:** The BPII has undergone a critical step in its psychometric and clinimetric evolution: structural validation. With the work completed in this study, the BPII and BPII 2.0 have completed assessment of seven of the nine Consensus-based Standards for the selection of health Measurement INstruments (COSMIN) properties including: 1) Internal consistency; 2) Reliability; 3) Standard error of measurement; 4) Content validation; 5) Structural validity; 6) Criterion validity; and, 7) Responsiveness testing. Completion of these assessments and the introduction of a structurally valid and shorter questionnaire, the BPII 2.0, provides a definitive level of credibility to this disease-specific outcome measure.

173 - Analysis of Failures following Medial Patellofemoral Ligament (MPFL) Reconstruction and Imbrication

**Laurie A Hiemstra, AB; Sarah Kerslake, AB; Mark R Lafave, AB**

**Purpose:** Patellofemoral instability is common injury and proximal soft tissue stabilization via MPFL reconstruction or imbrication is the mainstay of treatment. The contribution of certain pathoanatomies to the failure of patellofemoral stabilization is unknown. The purpose of this study was to analyse the failure rate of patellar stabilization procedures in a large cohort as measured by re-dislocation of the patella. A secondary purpose was to identify the pathoanatomical features that may have predisposed these patients to failure.

**Method:** Between May 2008 and March 2014, 207 MPFL reconstructions and 70 MPFL imbrications were performed by a single surgeon. Post-operative assessment included clinical examination to assess the integrity of the MPFL graft, plain radiographs and the Banff Patellofemoral Instability Instrument (BPII), a disease-specific outcome measure. Failures were identified and risk factors including trochlear dysplasia, patella alta, generalized ligamentous laxity (GLL), femoral tunnel position and rotational abnormalities were evaluated as contributing factors.

**Results:** There were 48 male and 178 female patients. The mean duration of follow-up was 24.1 months (SD 9.4, range 12-74). The average age at time of surgery was 24.81 years (SD 8.87, range 50.35-8.99). The average BMI was 23.75 (SD 3.62, range 36.70-14.90). There were 10 failures in the MPFL reconstruction group (4.8%), 1 male and 9 females. Femoral tunnel position was assessed in relation to Schottle’s point as good or excellent in all 10 cases. In terms of pathoanotomy, 8/10 failures had high-
grade trochlear dysplasia, 1/10 had patella alta, 6/10 had a Beighton score of \( \geq 4 \), and 3/10 had clinically significant rotational abnormalities of the lower extremity. The primary cause attributed to the 10 failure cases was trauma in two, trochlear dysplasia in three, rotational abnormalities in one, combined femoral anteversion and GLL in two, and combined trochlear dysplasia and GLL in two. There were 13 failures in the MPFL imbrication group (18.6%), 2 males and 11 females. Among these failures, 4/13 had high-grade trochlear dysplasia, 3/13 had patella alta, 10/13 had a Beighton score of \( \geq 4 \), and one had clinically significant rotational abnormalities of the lower extremity. The primary pathology that was considered to contribute to the imbrication failure cases was trochlear dysplasia in four, generalized ligamentous laxity in six, rotational abnormalities in one, patella alta with trochlear dysplasia in one, and generalized ligamentous laxity with trochlear dysplasia in one. Prior to surgical failure the mean BPII score for the failure group was 71.5/100, compared with 74.6/100 for the remainder of the cohort.

**Conclusion:** MPFL reconstruction is highly successful surgical procedure for stabilising the unstable patella with a failure rate of only 4.8%. Higher failure rates are seen in patients undergoing imbrication of the MPFL compared to a reconstruction. Pathoanatomies that contribute to failure vary between patients with the most common being trochlear dysplasia and generalized ligamentous laxity.

**174 - What can 1938 ACL Reconstructions Tell Us About Post-operative Laxity, Functional Performance and Quality of Life?**

**Rachel Ann Schachar, AB; S. Mark A Heard, AB; Laurie A Hiemstra, AB; Gregory M. L. Buchko, AB; Mark R Lafave, AB; Sarah Kerslake, AB**

**Purpose:** 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 clinical, functional and patient-centered outcomes a minimum of 1-year following ACL reconstruction. This study assessed for relationships between post-operative ACL graft laxity, functional testing performance, and scores on the ACL Quality of Life (ACL-QOL) questionnaire.

**Method:** A prospective cohort study design (n = 1938) was used to gather data on clinical laxity, functional performance and quality of life outcomes. Post-operative ACL laxity assessment using the Lachman and Pivot-shift tests was completed independently on each patient by a physiotherapist and an orthopaedic surgeon at a minimum of 12-months post-operatively. A battery of functional tests was performed including single leg balance, single leg landing, 4 single-leg hop tests, and tuck jumps. The hop tests provided a comparative assessment of limb-to-limb function including a single hop for distance, a 6m timed hop, a triple hop for distance, and a triple crossover hop. Patients completed the ACL-QOL at the 12-month and 24-month post-operative appointments. Descriptive and demographic data were collected for all patients. The degree and frequency of post-operative laxity was calculated. A Pearson r correlation coefficient was employed to determine the relationship between the presence of post-operative laxity and the ACL-QOL scores, between the battery of functional tests and the ACL-QOL scores, as well as between the functional tests and the laxity assessments.

**Results:** Data was gathered for 1512/1938 patients (78%). At clinical assessment a minimum of 1-year post-operatively, 13.2% of patients demonstrated a positive Lachman and/or Pivot-shift test. The mean
ACL-QOL score for patients with no ACL laxity was 80.8/100, for patients with a positive Lachman or Pivot-shift test the mean score was 72.3/100, and for patients with both positive Lachman and Pivot-shift tests the score was 66.9/100. Pearson r correlation coefficient demonstrated a significant relationship between the presence of ACL graft laxity and ACL-QOL score (p < 0.05). Statistically significant correlations were evident between all of the operative limb single-leg hop tests and the post-operative ACL-QOL scores (p < 0.05). Statistically significant correlations were evident between the operative limb triple-hop tests and presence of ACL graft laxity (p < 0.05).

**Conclusion:** Patients with clinically measurable ACL graft laxity demonstrate lower ACL-QOL scores as well as lower performance on a battery of functional tests. The disease-specific outcome measure was strongly correlated to the patient’s ability to perform single-limb functional tests, indicating that the ACL-QOL score accurately predicted level of function.

175 - Sex, Age, and Graft Size as Predictors of ACL Re-tear: A Multivariate Logistic Regression of a Cohort of 503 Athletes
Duong Nguyen, ON

**Comments:** ACL Outcomes Female sex Athletes Graft size Regression Analysis Young athletes

**Purpose:** Background The minimum size required for a successful quadrupled hamstring autograft ACL reconstruction remains controversial. The risks of ACL re-tear in younger patients who tend to participate in a higher level of sports activity, and female athletes who have numerous predisposing factors, are poorly defined. Purpose To identify risk factors for graft re-tears within 2 years of ACL surgery. The hypotheses are that female sex, a smaller size graft, and younger patients will increase the odds of failure. Study Design Cohort Study. Level of evidence, 3.

**Method:** A cohort of 503 athletes undergoing primary, autograft hamstring ACL reconstruction, performed by a single surgeon using the same surgical technique and rehabilitation protocol, between September-December 2012, was followed for a total duration of 2 years. Return to play was allowed between 6 and 12 months post-surgery upon completion of functional testing. Exclusion criteria included infections, revisions, double bundle techniques, multi-ligament injuries, non-compliance, BTB/allografts/hybrid grafts. Primary outcome consisted of binary data (ACL graft re-tear or no tear) as measured on physical exam (Lachman and pivot shift) and MRI. Multivariate logistic regression statistical analysis with model fitting was used to investigate the predictive value of sex, age, and graft size on ACL re-tear. Secondary sensitivity analyses were performed on the adolescent subgroup, age and graft size as categorical variables, and testing for interactions among variables. Sample size was calculated based on the rule of 10 events per independent variable for logistic regression.

**Results:** The mean age of the 503 athletes was 27.5 (SD 10.6; range = 12-61). There were 235 females (47%) and 268 males (53%) with a 6 % rate of re-tears (28 patients; 17 females). Mean graft size was 7.9 (SD 0.6; range = 6-10). Univariate analyses of graft size, sex, and age only in the model showed that younger age (odds ratio [OR] = 0.86; 95% confidence interval [CI] = 0.80-0.93; P = .001) and smaller graft size (OR = 0.36; 95% CI = 0.18-0.70; P = .003) were significantly predictive of re-tear. Female sex was correlated with re-tear but was not significant (OR = 1.8; 95% CI = 0.84-3.97; P = .13). Multivariate
analysis with all 3 variables in the model showed similar significant results. Graft size < 8 mm (OR = 2.95; 95% CI = 1.33-6.53; P = .008) and age < 25 (OR = 7.01; 95% CI = 2.40-20.53; P = .001) were significantly predictive of re-tear. Entire model was statistically significant (Omnibus test P = .001; Hosmer-Lemeshow statistic P = .68; Receiver Operating Curve [ROC] = 0.8).

**Conclusion:** Surgeons should counsel their patients who are female, younger than 25 and with a graft size less than 8 mm accordingly and consider modifying their surgical or rehabilitation techniques to mitigate these re-tear risks.

**176 - Increased Lateral Tibial Plateau Slope Predicts Increased Rotatory Knee Laxity in ACL-injured Patients**


**Purpose:** Knee laxity following anterior cruciate ligament (ACL) injury is a complex phenomenon influenced by various biomechanical and anatomical factors. The contribution of soft tissue injuries – such as ligaments, menisci, and capsule – has been previously defined, but less is known about the effects of bony morphology. (Tanaka et al, KSSTA 2012) The pivot shift test is frequently employed in the clinical setting to assess the combined rotational and translational laxity of the ACL deficient knee. In order to standardize the maneuver and allow for reproducible interpretation, the quantitative pivot shift test was developed. (Hoshino et al, KSSTA 2013) The aim of this study is to employ the quantitative pivot shift test to determine the effects of bone morphology as determined by magnetic resonance imaging (MRI) on rotatory laxity of the ACL deficient knee.

**Method:** Fifty-three ACL injured patients scheduled for surgical reconstruction (36 males and 17 females; 26±10 years) were prospectively enrolled in the study. Preoperative magnetic resonance imaging (MRI) scans were reviewed by two blinded observers and the following parameters were measured: medial and lateral tibial slope, tibial plateau width, femoral condyle width, bicondylar width, and notch width. (Musahl et al. KSSTA 2012). Preoperatively and under anaesthesia, a quantitative pivot shift test was performed on each patient by a single experienced examiner. An image analysis technique was used to quantify the lateral compartment translation during the maneuver. Subjects were classified as “high laxity” or “low laxity” based upon the median value of lateral compartment translation. (Hoshino et al. KSSTA 2012) Independent t-tests and univariate logistic regression were used to investigate the relationship between the pivot shift grade and various features of bone morphology. Statistical significance was set at p<0.05.

**Results:** A high inter-rater reliability was observed in all MRI measurements of bone morphology (ICC=0.72-0.88). The median lateral compartment translation during quantitative pivot shift testing was 2.8mm. Twenty-nine subjects were classified as “low laxity” (2.8mm). The lateral tibial plateau slope was significantly increased in “high laxity” patients (9.3+/−3.4mm versus 6.1+/−3.7mm; p<0.05). No other significant difference in bone morphology was observed between the groups.

**Conclusion:** This study employed an objective assessment tool – the quantitative pivot shift test – to assess the contribution of various features of bone morphology to rotatory laxity in the ACL deficient
knee. Increased lateral tibial plateau slope was shown to be a significant independent predictor of high laxity. These findings could help guide treatment strategies in patients with high grade rotatory laxity. Further research into the role of tibial osteotomies in this sub-group is warranted.

177 - Influence of the Femoral Nerve Block on Quadriceps Strength after Anterior Cruciate Ligament Reconstruction

Hamzah Ali Alhamzah, QC; Adam Hart, QC; Yazeed AlSaran, QC; Mark Burman, QC; Paul Martineau, QC

Comments: Our study is still in progress. The results mentioned in the abstract are preliminary results. The final results will be provided at the time of presentation.

Purpose: Over the past decade, the widespread availability of high-resolution ultrasonography coupled with advances in regional anaesthesia have popularized peripheral nerve blocks for anterior cruciate ligament reconstructions (ACLRs). The aim of this study is to investigate whether the femoral nerve block (FNB) administered at the time of ACLR has any long-term impact on the quadriceps strength as compared to patients who did not receive a FNB.

Method: This is a retrospective study. Four hundred charts of patients who underwent ACLR at our institution and had subsequent Biodex testing (an isokinetic rehabilitation test that provides objective information about muscle strength deficits and imbalances of the operated leg compared to the non-operated leg) from 2004 to 2015 were reviewed. Patients who had prior ipsilateral knee surgery, multiligament knee injury or at extreme ages were excluded from the study. The following baseline patient characteristics was recorded for each reviewed chart: age, sex, medical comorbidities, the date of the injury, date of the surgery, surgery technical notes and associated procedures, the surgeon, the hospital were the patient was operated, the Biodex test date and the Biodex test results. Data extraction assessed any association between the ACLR patients' who received FNB with the results of the Biodex test after completing the rehabilitation protocol. Descriptive statistics were used to compare the type of anaesthesia, mode of pain control and the results of the Biodex tests between patients grouped by the mode of anaesthesia used at the time of surgery (FNB versus no FNB). A multivariate regression model then compared quadriceps strength (inferred by Biodex test results) between groups while controlling for baseline differences between groups.

Results: Fifty five percent of the ACLR patients received FNB compared to 45% that did not receive FNB over the last 11 years of performing ACLRs (2004-2015) at our institute. Fifty percent of the patients that received FNB failed to achieve more than or equal to 80% quadriceps strength (compared to the contralateral non-operated leg) at 6 months on Biodex test. On the other hand, only 20% of the non-FNB group failed to achieve more than or equal to 80% quadriceps strength.

Conclusion: This study lead us to think that ACLR patients that received FNB are significantly weaker in quadriceps strength at 6 months post ACLR in comparison to non-FNB ACLR patients. This finding subsequently might affect the time needed to return to sports and might indicate a considerable clinical consequence of the FNB on ACL-reconstruction patients.
The Gross Anatomy and Histology of the Infrapatellar Plica, Central Body, and Fat Pad Suggests that they Function as an Enthesis Organ

Thomas V Smallman, US; Kris Shekitka, US; Ken Mann, US; Amos Race, US

Comments: This study documents the gross and histologic structure of the infrapatellar plica, and fat pad, and adds to an earlier report to the COA. The important new findings are that the femoral attachment of the plica is an enthesis, and that the plica itself is

Purpose: This study seeks to demonstrate that the structure of the fat pad (FP) and infrapatellar plica (IPP) is that of an enthesis organ.

Method: Twelve fresh frozen cadaver knees, each with an IPP, were dissected and the gross anatomic features recorded. The IPP and FP were harvested for study. Representative histologic sections were prepared on tissue fixed in 10% neutral buffered formalin, embedded in paraffin, cut at 4 microns on a rotatory microtome. Staining techniques included hematoxylin and eosin, Masson’s trichrome, elastic stain and S100. Appropriate decalcification of sections of the femoral insertion of the IPP was performed. All sections were examined by light microscopy at low, medium and high power. IPP types included 8 separate, 1 split, 2 fenestrated, and one vertical septum. The origin of the IPP is a fibrous arc arising from the apex of the notch separate from the margin of the articular cartilage. This attachment site is the instant center of rotation of the IPP and FP; they are thus not isometric. The central zone of the IPP consists of a mix of connective tissue types.

Results: Representative sections taken of the femoral attachment of the IPP display a transition zone between dense fibrillar collagen of the IPP, then fibrocartilage and cortical bone similar to a ligament attachment site or enthesis. The central plica histology is composed predominantly of dense regular connective tissue with variable clear space between the collagen bundles, and is thus ligamentous. There is abundant elastase staining throughout, as well as crimping of the collagen suggesting capacity for stretch. S100 staining demonstrates nerves around and in the substance of the IPP. The central body shows lobulated collections of mature adipose tissue admixed with loose connective tissue, containing abundant small peripheral nerves and vessels (all showing crimping and redundancy), merging with the dense fibrous tissue of the IPP. The FP is highly innervated, deformable, and fibro-fatty. Its histology shows lobules of fat, separated by connective tissue septa, which merge with the synovial areolar membrane surrounding the FP.

Conclusion: The linked structures, IPP, central body, and FP occupy the anterior compartment, and function as an enthesis organ: the IPP tethers the FP via the central body and together they rotate around the femoral origin of the IPP. They are not isometric, and must stretch and relax with knee motion. The histology correlates with this requirement. The origin of the IPP is an enthesis, a new observation. Elastase staining, redundancy of vessels and nerves, crimping and redundancy of the dense connective tissue all reflect the requirement to deform. The fat pad merges with the central body, both highly innervated space fillers, tethered by the IPP, which is a non-isometric ligament, also containing nerves. The important clinical significance of these structures is that release of the IPP at the origin reduces or eliminates anterior knee pain in most.
Outcomes and Experience with Fresh Osteochondral Allograft Transplantation of the Patella: A 5 Case Series

S. Mark Heard, AB; Sue Miller, AB; Rachel A Schachar, AB; Sarah Kerslake, AB

Purpose: Chondral defects on the patella are a difficult problem in the young active patient and there is no consensus on how to treat these injuries. Fresh osteochondral allografts are a valid option for the treatment of full-thickness osteochondral defects and can be used to restore joint function and reduce pain. The primary purpose of this study was to investigate the clinical and subjective outcomes of a series of patients following fresh osteochondral allograft transplantation for isolated chondral defects of the patella.

Method: A series of 5 patients underwent surgery using an open approach for graft transplantation. A strict protocol for the allograft tissue was followed. Transplant recipients must be aged <60, have a full-thickness, isolated chondral lesion and have failed previous traditional treatments. The fresh allografts are hypothermically stored at 4°C in X-VIVO10 media for up to 30 days to maintain cartilage viability. Pre- and post-operative clinical measures including knee stability, range of motion, and quadriceps girth were completed. Post-operative plain radiographs were completed including weight-bearing AP, lateral and skyline views. Patient-centred outcome measures including the Knee Osteoarthritis Outcome Score (KOOS) and the Knee Society Score (KSS) were gathered a minimum of 1-year post-operative. Descriptive and demographic data were collected for all patients. A paired t-test was employed to determine the difference between the pre-operative and post-operative outcomes.

Results: All patients were female, with a mean age of 27.4 (SD 3.65). Knee ligament stability was similar pre- and post-operatively. Knee ROM assessment of flexion and extension demonstrated a less than 10° increase from pre to post-operative. Quadriceps girth measurements demonstrated a mean change of 0.5 cm from pre- to post-operative for the surgical limb. Post-operative radiographs demonstrated incorporation of the graft in 4/5 cases within 6-months of surgery. One patient developed fragmentation of the graft after 18-months, and one patient had a subsequent trochleoplasty for persistent pain. The mean KOOS domain scores demonstrated significant improvement (p<0.05) as follows: Symptoms pre-op = 28.57, post-op = 55; Pain pre-op 28.89, post-op = 57.22; ADLs pre-op = 48.92, post-op = 66.18; Sports/Recreation pre-op = 6, post-op = 32; and QoL pre-op = 12.5, post-op = 42.5. Mean pre-op surgical versus non-surgical limb KSS scores were 107.4 and 179 respectively. The mean post-op surgical versus non-surgical limb KSS scores were 166 and 200.

Conclusion: Isolated chondral defects of the patella can cause substantial pain, reduced function, and can be challenging to address surgically. This series of 5 cases demonstrated improved function, KOOS and KSS for 4/5 patients. To our knowledge this is a novel biological procedural technique for this problem, which has shown promising results making it a viable treatment option for young active patients with osteochondral defects of the patella.

Anica Bienc Fellow - Autologous Chondrocyte Implantation of the Femoral Condyles – Ten-year Clinical and Radiographic Results from a Single Centre

David Martincic, Slovenia
**Purpose:** A prospective case control study analysed clinical and radiographic results in patients operated on with the periosteum autologous chondrocyte implantation (ACI) due to cartilage lesions on the femoral condyles over 10 years ago.

**Methods:** 31 out of the 45 patients (3 failures, 9 non-responders, 2 others) were available for a continuous clinical (Lyshom/Tegner, IKDC, KOOS) and radiographic (Kellgren-Lawrence) follow-up at 0, 2, 5, and 10 years after the ACI procedure. The patients were sub-grouped into focal cartilage lesions (FL) – 10, osteochondritis dissecans (OCD) – 12, and cartilage lesions with simultaneous ACL reconstruction (ACL) – 9 subgroups.

**Results:** Lysholm, Tegner, and IKCD subjective scores revealed stable results over the period from 2 to 10 years with a significant improvement toward the pre-operative levels, but the patients had not reached their pre-injury Tegner levels. KOOS profile at 10 years was: Pain 78.6, Symptoms 78.1, Activities of daily living 82.5, Sports 56.9, and Quality of life 55.1. A 10-year IKDC knee examination classified operated knees as: 14 normal, 10 nearly normal, 5 abnormal and 2 severely abnormal. Kellgren-Lawrence scores of 2 and above were found in 10 patients (FL 5, OCD 0, and ACL 5). Seven patients in the group required an arthroscopic re-intervention (3 ACI related, 4 ACI unrelated).

**Conclusions:** ACI provided safe and stable performance of operated knees over ten years. High incidence of knee osteoarthritis in FL and ACL subgroups, and low incidence in OCD patients indicate that best long performance is expected in localized low-impact cartilage lesions of young patients.
**Paper Session:** COA Trauma 2: Hip Trauma

**180 - Cumulative Incidence of In-hospital Mortality following Hip Fracture by Hospital Type in Canada, 2004-2012: Database Study**

Katie Jane Sheehan, BC; Boris Sobolev, BC; Pierre Guy, BC; Lisa Kuramoto, BC; Suzanne Morin, QC; Jason Sutherland, BC; Lauren Beaupre, AB; Donald Griesdale, BC; Michael Dunbar, NS; Eric Bohm, MB; Edward Harvey, QC

**Purpose:** Hospital type is an indicator for structures and processes of care. The effect of hospital type on hip fracture in-hospital mortality is unknown. We determine whether hip fracture in-hospital mortality differs according to hospital type.

**Method:** We retrieved records of hip fracture for 167,816 patients aged 65 years and older, who were admitted to a Canadian acute hospital between 2004 and 2012. For each hospital type we measured and compared the cumulative incidence of in-hospital death by in-patient day, accounting for discharge as a competing event.

**Results:** The cumulative incidence of in-hospital death at in-patient day 30 was lowest for teaching hospital admissions (7.3%) and highest for small community hospital admissions (11.5%). The adjusted odds of in-hospital death were 12% (95% CI 1.06-1.19), 25% (95% CI 1.17-1.34), and 64% (95% CI 1.50-1.79) higher for large, medium, and small community hospital versus teaching hospital admissions. The adjusted odds of nonoperative death were 1.6 times (95% CI 1.42-1.86), and 3.4 times (95% CI 2.96-3.94) higher for medium and small community hospital versus teaching hospital admissions. The adjusted odds of postoperative death were 14% (95% CI 1.07-1.22) and 20% (95% CI 1.10-1.31) higher at large and medium community hospitals versus teaching hospitals. The adjusted odds of postoperative death were largest at small community hospitals but the confidence interval crossed 1 (OR = 1.25, 95% CI 0.92-1.70).

**Conclusion:** A higher proportion of hip fracture patients die at non-teaching compared to teaching hospitals accounting for length of stay. Higher mortality at small community hospitals may reflect disparities in access to resources and delay to treatment.

**181 - Significance and Factors Associated with Malnutrition in a Geriatric Population Admitted for Hip Fracture**

Hugo Messier, QC; Dominic Plante, QC; Stéphane Pelet, QC

**Purpose:** This paper presents the nutritional status of a geriatric population admitted for hip fracture. Malnutrition is often associated with the advanced age and can be influenced by physical, mental, social and environmental changes. Hip fracture is a major issue and a prior poor nutritional status is associated with higher rates of perioperative complications and prolonged hospital length of stay. Methods: Prospective observational

**Method:** Prospective observational cohort study performed in a Level one trauma center including 110 consecutive patients admitted for hip fracture. The main outcome measure was the Mini Nutritional Assessment (MNA), a specific tool validated for geriatric population. This questionnaire was performed
at admission by an independent assessor, at the same time as a large set of demographic and functional
data. Blood samples were tested for blood count and albuminemia. Two groups were constituted and
analysed according to a MNA score > 24 (lower limit for normal nutritional status). Factors explored
included physical and mental items. Impact of malnutrition was determined on hospital length of stay
(HLS), discharge in an adverse location than prior to admission (DAL), complications and mortality rate.

Results: The rate of patients with malnutrition (or at risk) in this study is 49.1% (54 patients). Patients
with a MNA < 24 are older (83.6 yrs ± 6.5 vs 80.2 ± 8.3, p<0,01), have more comorbidities (Charlson 2.5
vs 1.27, p<0,01), a more impaired mental (MMSE <27 74.1% vs 41.1%, p<0,01) or physical status (MIF
105.3 26.6 vs 121.8 6.4, p<0,01). Blood samples are not selective to detect malnutrition (p=0,64).
Malnutrition is associated with a longer HLS (25.2 days 24.2 vs 14.2 9.0, p<0,01), a greater DAL
(58.9% vs 38.2%, p=0,02) and a higher 6 months mortality rate (16.7% vs 3.6%, p=0,02).

Conclusion: The prevalence of malnutrition in a geriatric population admitted for hip fracture is high.
Blood samples at admission have clearly a poor value and a systematic screening with the MNA is
mandatory. An early diagnosis will target specific interventions in order to reduce the physical and socio-
economic impact of the malnutrition. Future studies should focus on actions in the perioperative stage
(fast-track surgery, nutritional protocols, analgesia) and their impact on the socio-economic burden.

182 - Short versus Long InterTAN Fixation for Geriatric Intertrochanteric Hip Fractures: A Prospective,
Multi-centre Head-to-Head Comparison

Michael E Sellan, ON; Dianne Bryant, ON; Christina Tieszer, ON; Mark MacLeod, ON; Steven R Papp, ON;
Abdel-Rahman Lawendy, ON; Alan Liew, ON; Darius Viskontkas, BC; Chad Coles, NS; Timothy P Carey,
ON; Wade Gofton, ON; Andrew Trendholm, NS; Trevor Stone, BC; Ross Leighton, NS; David W Sanders,
ON

Purpose: The benefit of using a long intramedullary device for the treatment of geriatric
intertrochanteric hip fractures is unknown. The InterTAN device (Smith and Nephew, Memphis TN) is
offered in either Short (180-200 mm) or Long (260-460 mm) constructs and was designed to provide
stable compression across primary intertrochanteric fracture fragments. The objective of our study was
to determine whether Short InterTANs are equivalent to Long InterTANs in terms of functional and
adverse outcomes for the treatment of geriatric intertrochanteric hip fractures.

Method: 108 patients with OTA classification 31A-1 and 31A-2 intertrochanteric hip fractures were
included in our study and prospectively followed at one of four Canadian Level-1 Trauma Centres. Our
primary outcomes included two validated primary outcome measures: the Functional Independence
Measure (FIM), to measure function, and the Timed Up and Go (TUG), to measure motor performance.
Secondary outcome measures included blood loss, length of procedure, length of stay and adverse
events. A pre-injury FIM was measured by retrospective recall and all postoperative outcomes were
assessed on postoperative day 3, at discharge, at 6 weeks, 3 months, 6 months and 12 months
postoperatively. Unpaired t-tests and Chi-square tests were used for the comparison of continuous and
categorical variables respectively between the Short and Long InterTAN groups. A statistically significant
difference was defined as p<0.05.
Results: Our study included 71 Short InterTAN and 37 Long InterTAN patients with 31A-1 and 31A-2 intertrochanteric hip fractures. Age, sex, BMI, side, living status and comorbidities were similar between the two groups. The mean operative time was significantly lower in the Short InterTAN group (61 mins) as compared to the Long InterTAN group (71 mins)(p<0.05). There were 5 periprosthetic femur fractures in the short InterTAN group versus 1 in the long InterTAN group. Non-mechanical adverse outcomes such as myocardial infarction, pulmonary embolism, urinary tract infections, pneumonia and death all had similar incidence rates between the two InterTAN groups.

Conclusion: Both the Short and Long InterTAN patient cohorts displayed similar improvements in performance and overall function over the course of a year following intertrochanteric hip fracture fixation. The recorded operative times for Short InterTAN fixation were significantly shorter than those recorded for the Long InterTAN patients. Alternatively, a significantly higher proportion of Short InterTAN patients sustained periprosthetic femur fractures within a year of implantation as compared to the Long InterTAN group.

183 - Results of Octaplex for Reversal of Warfarin Anticoagulation in Hip Fracture Patients
Richard Ng, AB; Meer-Taher Shabani-Rad, AB; Charlie MacAdams, AB

Purpose: Hip fractures are a common cause of morbidity and mortality in the elderly, with approximately 30,000 hip fractures a year in Canada. Many hip fracture patients are prone to heart failure and present anticoagulated with Warfarin for medical comorbidities including atrial fibrillation or previous thromboembolic disease. Reversal of warfarin anticoagulation to an INR < 1.5 preferred for surgery but this often contributes to a delay to hip fracture surgery, which increases patient pain, morbidity, mortality, and length of stay Octaplex is a small-volume prothrombin complex concentrate (PCC) that reverses Warfarin-related anticoagulation in 15-60 minutes. It has been shown to be safe and effective in the management of intracranial and gastrointestinal bleeding in warfarinized patients. It is recommended by Bone and Joint Canada as an option for urgent warfarin reversal in hip fracture patients. However, there has been no published literature on the use of Octaplex or other PCCs in orthopaedic patients. Our objective is to assess the effectiveness of Octaplex for rapid reversal of warfarin anticoagulation in hip fracture patients.

Method: A database review of all patients who received Octaplex was performed. Medical records of all hip fracture patients in Calgary who received Octaplex between December 2009 and February 2015 were reviewed. After application of inclusion and exclusion criteria, 33 patients were identified. A timeline of International Normalized Ratio (INR), Octaplex administration, and hip fracture surgery was recorded. Mortality and complications were assessed at 30 days.

Results: A single dose of Octaplex corrected the INR to < 1.5 in 29 cases (88%). Median time from administration of Octaplex to a measured INR < 1.5 was 1.1 hours. Median time from admission to hip fracture surgery was 22 hours. Mortality at 30 days was 15.2%, mostly from cardiac arrest. A further 12% of patients developed cardiac or thrombotic complications. Multiple medical comorbidities were common including coronary artery disease (55%), congestive heart failure (45%), and chronic pulmonary disease (39%). Patients who received both fresh frozen plasma (FFP) and Octaplex for warfarin reversal
had much higher mortality than those who only received Octaplex (40% vs 4.3% mortality at 30 days), but also had more medical comorbidities.

**Conclusion:** Octaplex is effective at rapidly reversing warfarin anticoagulation and reducing time to surgery, potentially reducing the morbidity and mortality of hip fractures. Administration of both Octaplex and FFP were associated with higher early mortality in this case series. Further research is required to assess the safety of Octaplex, vitamin K, and FFP for reversal of warfarin anticoagulation in this population.

184 - Correlation between Serum CTX-1 and Perceived Compliance to Treatment in Patients with Frailty Fractures: Prospective Cohort Study of 543 Patients

**Myriam Bellemare, QC; Josée Delisle, QC; Yves Troyanov, QC; Sylvie Perreault, QC; Andréa Senay, QC; Andreea Banica, QC; Pierre Beaumont, QC; Mario Giroux, QC; Alain Jodoin, QC; G Yves Laflamme, QC; Stéphane Leduc, QC; Jean-Marc MacThiong, QC; Michel Malo, QC; Gilles Maurais, QC; Hai Nguyen, QC; Stéphan Parent, QC; Pierre Ranger, QC; Dominique M Rouleau, QC; Julio C Fernandes, QC**

**Purpose:** Treat to target is the use of a physiologic marker as a monitor of effectiveness or compliance to an intervention. A recent example has been the progressive use of CTX-1 (Marker of osteoclastic activity) as a surrogate of bone resorptive activity in osteoporosis treatment. CTX-1 levels were demonstrated to be inversely related to drug efficacy in the suppression of bone resorption. As far as fragility fractures are concerned, no reference value of CTX-1 for any index fracture sites was found in the literature. In order to prevent subsequent fractures, efforts to better manage this chronic disease are to be explored. The main objective of this study was to compare and validate the use of serum CTX-1 to the perceived compliance to treatment.

**Method:** Five hundred and forty three patients (men and women) 40 years of age or older who had been treated for a fragility fracture were enrolled. The purpose of this study was to correlate the measurement of CTX-1 with the perceived compliance to treatment of patients at the time of fracture and at six, 12 and 18 months after initiation of treatment. Our secondary objectives were to evaluate two different CTX-1 suppression target levels (CTX-1< 0.3 ng/mL and CTX-1<0.2 ng/mL), to determine CTX-1 values according to fracture sites, and to explore the profile of patients with subsequent fractures.

**Results:** Considering index fractures, compliant patients under treatment at baseline had lower CTX-1 levels than non-compliant patients (p=0.052). Patients who were compliant to treatment at six, 12 and 18 months also had lower CTX-1 levels than non-compliant patients (p=0.000). When index fractures were divided into fracture sites, regardless of CTX-1 suppression target level (i.e. CTX-1< 0.3 or 0.2 ng/mL), significant CTX-1 suppression was observed in non-hip and non-vertebral (NHNV) fractures at six, 12 and 18 months (p0.05). No clinically relevant difference was observed between the profile of patients with and without subsequent fractures.

**Conclusion:** The correlation between serum CTX-1 at the time of fracture and at six, 12, 18 months and the perceived compliance to treatment was validated for NHNV fractures supporting the concept of the available treatments and their effects on bone remodeling for this type of fracture. The correlation was
not validated for hip neither for vertebral fracture. There was no correlation between CTX-1 levels and subsequent fracture risk.

185 - Time to Surgery and Thirty-day Major Complications Following Hip Fracture - Time is of the Essence
Adam Hart, QC; Laura Epure, QC; Stéphane G Bergeron, QC; Olga Huk, QC; David Zukor, QC; John Antoniou, QC

**Purpose:** Hip fractures are among the most common orthopaedic injuries and represent a growing burden on healthcare as our population ages. Despite improvements in preoperative optimization, surgical technique and postoperative care, complication rates remain high. Time to surgery is one of the few variables that may be influenced by the medical team. The aim of the present study was to evaluate the impact of time to surgery on mortality and major complications following surgical fixation of hip fractures.

**Method:** Utilizing the American College of Surgeons’ National Quality Improvement Program (NSQIP) database, we analyzed all hip fractures (femoral neck, inter-trochanteric, and subtrochanteric) treated from 2011 to 2013 inclusively. We divided patients into three groups based on time to surgery: less than one day (<24h), one to two days (24-48h), and two to five days (48-120h). Baseline characteristics were compared between groups and a multivariate analysis performed to compare 30-day mortality and major complications (return to surgery, deep wound infection, pneumonia, pulmonary embolus, acute renal failure, cerebrovascular accident, cardiac arrest, myocardial infarction, or coma) between groups.

**Results:** A total of 14,730 patients underwent surgical fixation of a hip fracture and were included in our analysis. There were 3,475 (24%) treated <24h, 9,960 (67%) treated 24-48h, and 1,295 (9%) treated 48-120h. Thirty-day mortality and major complication rates were 5.0% and 6.2% for the <24h group, 5.3% and 7.0% for the 24-48h group, 7.9% and 9.7% for the 48-120h group respectively. After controlling for baseline demographic differences between groups (age, sex, race) as well as pertinent comorbidities (diabetes, dyspnea, chronic obstructive pulmonary disease, chronic steroid use, hypertension, cancer, bleeding disorders, and renal failure), time to surgery beyond 48h resulted in greater odds of both mortality (1.45, 95%CI 1.10-1.91) and major complications (1.45, 95%CI 1.12-1.84).

**Conclusion:** Time to surgery is one of the few variables that can be influenced by timely medical assessment and access to the operation room. Expediting surgery within 48h of hip fracture is of paramount importance as it may significantly reduce the risk of mortality as well as major complications.

186 - Does the Surgical Treatment of Hip Fractures within Two-days of Injury Improve Patient Outcomes? An Analysis of 26,066 Cases from ACS-NSQIP
Nathan O’Hara, BC; Michael Neufeld, BC; Min Zhan, US; Yongliang Zhai, BC; Henry A Broekhuysse, BC; Kelly Lefaivre, BC; Joshua M Abzug, US; Gerard P Slobogean, US

**Purpose:** The effect of early surgery on hip fracture outcomes has received considerable study and although it has been suggested that early surgical treatment of these fractures leads to better patient outcomes, the findings are inconclusive. The American College of Surgeon’s (ACS) National Surgical
Quality Improvement Project (NSQIP) prospectively collects blinded, risk-adjusted patient-level data on surgical patients in over 600 participating hospitals worldwide. The primary objective of this study was to determine the proportion of ACS-NSQIP hospital patients that are currently being treated within the UK’s National Institute for Health and Care Excellence (NICE) time to hip fracture surgery benchmark. The secondary objectives were to identify risk factors for missing the benchmark, and determine if the benchmark is associated with improved 30-day patient outcomes.

**Method:** Patients that underwent hip fracture surgery between 2005-2013 and entered in the ACS-NSQIP database were included in the study. Counts and proportions were used to determine how frequently the NICE benchmark was met. Multivariate regression analysis was used to identify significant predictors of missing the NICE benchmark and determine if missing the benchmark was associated with 30-day mortality/complications rates.

**Results:** 26,006 patients met the study enrolment criteria. 71.4% of patients were treated within the NICE benchmark and 89.4% were treated by post-admission day two. Gender, dyspnea, infectious illness, bleeding disorders, preoperative hematocrit, preoperative platelet count, arthroplasty procedure type, race other than White, and hip fracture diagnosis were all statistically significant predictors of missing the benchmark (p<0.01). Meeting the NICE benchmark was not associated with reductions in major complications (OR=0.93, CI=0.83-1.05, p=0.23), nor a clinically significant difference in postoperative length of stay (LOS) (parameter estimate=0.77, p<0.01); however, it was associated with a decreased 30-day mortality (OR=0.88, CI=0.78-0.99, p=0.03) and the likelihood of minor complications (OR=0.92, CI=0.84-0.995, p=0.04).

**Conclusion:** ACS-NSQIP hospitals are currently compatible with the NICE benchmark. However, data from the ACS-NSQIP database suggests that surgical treatment within the NICE benchmark may be unnecessarily narrow. Extending the benchmark to post-operative day two did not significantly increase the risk of 30-day mortality and minor complications; nor did it extend the average LOS. Neither the NICE benchmark, nor the extended two-day standard, was associated with reductions in major complications. The findings highlight the importance of further prospective investigation to monitor the effect of time to surgery benchmarks.

187 - The Radiographic Union Score for Hip (RUSH) Can Define Non-union and Predict Revision Surgery for Femoral Neck Fractures: Sub-group Analysis of a Multi-center Hip Fracture Trial

**Tym Frank, BC; Georg Osterhoff, BC; Sheila Sprague, ON; Alisha Hak, ON; Mohit Bhandari, ON; Gerard Slobogean, US; FAITH Investigators, ON**

**Purpose:** The Radiographic Union Score for Hip (RUSH) is an outcome instrument designed to describe radiographic healing of femoral neck fractures. The ability to identify fractures that have not healed is important for defining non-union in clinical trials and predicting patients that likely require additional surgery to promote fracture healing. We sought to determine a RUSH threshold score that defines nonunion at 6-months post-injury. Our secondary objective was to determine if this threshold was associated with increased risk for non-union surgery.
Method: A sample of 248 patients with adequate six-month hip radiographs and complete two-year clinical follow-up were analyzed from a multi-national hip fracture trial (FAITH). All patients had a femoral neck fracture and were treated with either multiple cancellous screws or a sliding hip screw. Two reviewers independently determined the RUSH score based on the six-month post-injury radiographs, and agreement was assessed using the Interclass Correlation Coefficient (ICC). Fracture healing was determined by two independent methods: 1) prospectively by the treating surgeon using clinical and radiographic assessments, and 2) retrospectively by a Central Adjudication Committee using radiographs alone. Receiver Operator Curve analysis was used to define a RUSH threshold score that was specific for fracture nonunion.

Results: RUSH score inter-rater agreement was high (ICC: 0.81, 95% CI 0.76 to 0.85). The mean six-month RUSH score for all included patients was 24.4 (SD 3.4). A threshold score of <18 was associated with a greater than 98% specificity for nonunion. Furthermore, patients with a six-month RUSH score below 18 were more the seven-times more likely to require revision surgery for nonunion (Relative Risk: 7.25, 95% CI 2.62 to 20.00).

Conclusion: The six-month RUSH score can effectively be used to communicate when a femoral neck fracture has not healed. The validity of our conclusions was further supported by the increased risk of nonunion surgery for patients below the RUSH threshold. We believe our findings can standardize a definition of nonunion for clinical trials and recommend the use of the RUSH and its <18-point threshold when describing femoral neck nonunion.

188 - Fracture Liaison Service: An Effective Approach to Improve Post Hip Fracture Care in Seniors Through Osteoporosis Management

Paul Kivi, AB; Angela Juby, AB; David Hanley, AB; Liz Evens, AB; Shannon Falsetti, AB

Purpose: In Alberta there are over 2,700 hip fractures per year costing the health system over $24 million in acute care costs alone. 50% of hip fracture patients have had a prior fragility fracture as a result of underlying osteoporosis (OP) that has never been assessed or appropriately treated. The Fracture Liaison Service (FLS) in Alberta aims to improve appropriate osteoporosis care, highlight and address gaps within seniors care through OP management, and provide a geriatric syndrome triage service.

Method: The FLS has developed a linkage with the Emergency Department (ED) geriatric team whereby hip fracture patients are identified in ED using a screening tool for geriatric syndromes prior to their surgery, allowing the FLS to follow through on comorbidities likely contributing to falls. An inpatient orthopaedic unit with a dedicated Registered Nurse (RN) and a Care of the Elderly Physician see and assess hip fracture patients after surgery for appropriate osteoporosis management and treatment. Screening tools have been developed to quickly detect underlying dementia and to quantify frailty to determine life expectancy and appropriate osteoporosis therapy. Patients are also referred to Geriatric Assessment Units and fall prevention programs. Patients are then contacted in the community at 3, 6,9,12 months by the FLS RN to follow up on osteoporosis therapy, and arrange other needed tests (i.e. bone mineral density, vitamin D) as needed. Information is sent to their family physician with all results.
Prior to the patient’s discharge from the FLS at one year, a final hand-over letter from the program will be provided outlining the plan of care for the patient.

**Results:** The FLS launched in June 2015 at the Misericordia hospital in Edmonton, Alberta (with plans to expand provincially). Currently 3 out of 4 hip fracture patients per week are being identified in the ED. Ninety-eight hip fracture patients have been identified post-surgery, with 71 patients eligible for enrollment in the program (five deceased patients). Sixty-six (50%) of those enrolled were discharged on osteoporosis medication compared to 8% prior to the program initiation. Seventeen (26%) of those were new medication starts. Of those not started, 7(11%) was patient choice. 11(31%) will be reassessed at 3 months for appropriate therapy. Nineteen (27%) of patients were referred to other inpatient or outpatient programs (i.e. falls, memory). Three month follow up calls have begun with patients for further data collection and a full 1 year qualitative and quantitative evaluation will be done.

**Conclusion:** The implementation of an FLS with dedicated personnel to proactively manage and treat patients with appropriate investigations and interventions can close the care gap that exists in OP care. It also addresses gaps in senior care and provides appropriate referral to community geriatric programs, to improve quality of life and prevent future fractures.
**Paper Session:** COA Adult Reconstruction Hip 3: Revisions

**189 - The Cup Cage Reconstruction for Pelvic Discontinuity Has Excellent Patient Satisfaction and Good Functional Outcome at Median 6-year Follow Up**

Nelson Greidanus, BC; Donald Garbuz, BC; Sujith Konan, England; Clive Duncan, BC; Bas Masri, BC

**Purpose:** Revision surgery for pelvic discontinuity in the presence of bone loss is challenging. The cup-cage reconstruction option has become popular for the management of pelvic discontinuity in the recent years. The aim of this study was to review the clinical, radiological and patient reported outcomes with the use of cup cage construct for pelvic discontinuity at our institution.

**Method:** Twenty-seven patients (27 cup-cage reconstructions) were identified at median 6-year (minimum 2 year, maximum 10 years) follow up. Eight were female patients. The median age was 77 years [mean 72, range 37-90, SD 13.6]. There were 5 deaths and 2 were lost to follow up.

**Results:** Two patients were converted to excision arthroplasty; one for infection and one for failure of the construct. A further 3 patients required revision for instability but the cup cage construct was not revised (2 revisions of cemented cups to a constrained cup and one revision of proximal modular component of the femoral prosthesis). Revision of the cup cage construct was not necessary in any of these cases. We noted excellent pain relief (mean WOMAC pain 85.6) and good functional outcome (mean WOMAC function 78.2, mean UCLA 5, mean OHS 78.6). Patient satisfaction with regards pain relief; function and return to activities were noted to be excellent. Radiological changes were noted in further 4 patients (cup migration in one case; fracture of ischial spike in one case and breakage of the cage screws in 2 patients). No migration of the construct was noted in any of the cases.

**Conclusion:** In conclusion, the cup cage construct is an excellent method of dealing with complex pelvic discontinuity. Our study suggests a low failure rate; high patient satisfaction and pain relief and moderate functional outcome at median 6 year follow up.

**190 - Increased Aseptic Loosening in Non-large-Head Metal-on-Metal Hip Arthroplasty**

Colin Burnell, MB; Bryan Flynn, MB; Trevor Gascoyne, MB; Kevin Stockwell, MB; Thomas R Turgeon, MB

**Purpose:** Non-large head Metal-on-metal (MoM) hip replacements were seen as a solution to concerns about implant wear in younger patients. Mid-term loosening of once well-fixed hydroxyapatite (HA) coated femoral stems was recently observed in select MoM patients upon revision surgery. Accordingly, an implant retrieval study was undertaken to examine the incidence of aseptic loosening of in HA-coated femoral stems with MoM, ceramic on ceramic (CoC) and metal on polyethylene (MoP) bearing couples.

**Method:** A single-centre implant retrieval lab reviewed 44 hydroxyapatite (HA)-coated titanium wedge taper stems of the same design retrieved over a period of 9 years. Ten were MoM articulations, 23 MoP and 11 CoC. Head sizes ranged from 28 to 40 with only four 40mm heads, all of which were MoM. Reason for revision, duration of implantation, femoral head size, patient age and body mass index was recorded for each retrieval. Goldberg corrosion scores were determined for the taper surfaces of each retrieval, with ‘0’ indicating no corrosion and ‘3’ indicating severe corrosion. Logistic regression analysis, Wilcoxon Rank Sum and Fischer’s exact test were used for statistical analysis.
Results: Aseptic loosening was the listed reason for revision in 18 of 44 cases. MoM bearing was associated with increased probability of aseptic loosening (Odds ratio 7.1 (95%CI 1.1-47.0) p=0.042). Severity of corrosion was also associated with aseptic loosening (Odds ratio 2.75 (95%CI 1.1-6.6) p=0.02). Head size and patient age had no correlation. Median time to revision of implants for aseptic loosening was 4.5 years (range: 4.2-7.0 years) for MoM versus 1.4 years (range: 0.3-3.0) for other bearing couples (p=0.004). Aseptic loosening was categorized as early (<=2 years) or mid-term (>2 years). No MoM hips were revised for aseptic loosening in the first 2 years while 8 of the 11 mid-term revisions had MoM articulations (p=0.004). Taper corrosion was more severe in mid-term aseptic loosening cases (p=0.049).

Conclusion: MoM HA-coated hip replacements appear to be associated with increased mid-term aseptic loosening compared to other bearing couples. Patients with MoM HA-coated hip replacements should be monitored regularly beyond the initial 1 to 2 years following surgery. Future analyses will examine the presence and progression of femoral radiolucency prior to revision surgery to determine an approximate timeline of stem loosening in this patient cohort. This research highlights the importance of implant retrieval programs to assess post-revision implant characteristics for early identification of possible device issues.

191 - Irrigation and Debridement versus Two-stage Revision for Treatment of Infected Total Hip Arthroplasty: A Comparison of Functional Outcomes

Mark Nyland, ON; Brent Lanting, ON; Lyndsay Somerville, ON; Edward Vasarhelyi, ON; Douglas Naudie, ON; James McAuley, ON; Richard McCalden, ON; Steven MacDonald, ON; James Howard, ON

Purpose: Infection following total hip arthroplasty (THA) represents a devastating complication and is one of the main causes for revision surgery. This complication may be treated by irrigation and debridement with head and polyethylene exchange (IDHPE) or a two-stage revision (2SR). Previous studies have reported on the eradication success rates but few have reported patient outcome scores. The purpose of this study was to report patient outcome scores for both IDHPE and 2SR and compare these to a non-infected matched cohort. We hypothesized that both cohorts would have worse outcomes than the control group, and that those who failed an initial IDHPE and required a 2SR would have a worse outcome than those treated initially with a 2SR.

Method: A retrospective review identified 137 patients from our institutional arthroplasty database who had an infected primary THA between 1986-2013. We excluded patients with less than one-year follow-up. Mean follow-up was 60 months (12-187 months). A control cohort was identified and matched according to age and Charlton Comorbidity Index (CCI). Harris Hip Scores, Short Form 12 and WOMAC scores were compared between our control group and our infected cohort.

Results: Sixty-eight patients were treated with a 2SR and 69 patients were treated with an IDHPE. There was a 59% success rate in eradicating the infection with an IDHPE. All of the 28 patients who failed an IDHPE later went on to a 2SR. Outcome scores for the 2SR cohort were significantly worse than the non-infected controls (p<0.05). There was no difference in outcome scores when comparing our 2SR cohort to our failed IDHPE (p>0.05).
Conclusion: Previous studies have focused on eradication rates. However, it is important to consider patient outcome scores when deciding the best treatment. Infected patients treated with a successful IDHPE had similar outcomes to non-infected patients. Patients that failed IDHPE and went onto 2SR had similar outcomes to those that had a 2SR alone. IDHPE should still be considered in the treatment algorithm of infected THA.

192 - Health Related Quality of Life is Maintained with Long-term Retention of the PROSTALAC System Following Infection Resolution in Low Demand Patients
Kyle Stampe, AB; Lauren Beaupre, AB; Edward Masson, AB; Gregory O’Connor, AB; Marcia Clark, AB; Mark Joffe, AB; Lesia Boychuk, AB; Guy Lavoie, AB

Purpose: Periprosthetic joint infection is a significant complication of total hip arthroplasty. The PRSThesis of Antibiotic Loaded Acrylic Cement (PROSTALAC) system can improve health related quality of life during a two step treatment approach for infection resolution. We investigated quality of life with the PROSTALAC in situ and also compared subjects who underwent second stage surgery with those who retained the PROSTALAC on a long term basis.

Method: Twenty nine subjects were enrolled pre-PROSTALAC insertion, recording demographics, physical demand level and comorbidities. Subjects were then followed out to 24 months with either the PROSTALAC in situ or post revision for those who underwent the second stage surgery. Quality of life was evaluated using the Western Ontario McMaster Osteoarthritis Index (WOMAC) and RAND 36-Item Health Survey (RAND-36). Infection resolution was also determined for all subjects enrolled.

Results: Three subjects died and 22/26 (84%) completed the evaluation. Overall 26 (85%) infections resolved. Following PROSTALAC insertion, WOMAC pain and function scores improved within three to six months and did not change out to 24 months. Physical function, bodily pain and vitality also significantly improved within three to six months postoperatively. Only seven (32%) subjects underwent second stage surgery. These individuals were more likely to be high demand (p=0.03) and trended towards being younger, male, with fewer comorbidities and lower BMI (p<0.10). There was no difference in WOMAC scores at 24 months between those who underwent second stage revisions and those who retained the PROSTALAC.

Conclusion: The use of a PROSTALAC implant improves health related quality of life. Long term retention of the PROSTALAC implant may be appropriate for low demand patients and considered for potentially high risk surgical candidates.

193 - Prevention of Dislocation with the Dual Mobility Concept During THA Revision with Severe Bone Loss, About 123 Cases
Rémi Philippot, France; Bertrand Boyer, France; Thomas Neri, France; Frederic Farizon, France

Purpose: The main causes of total hip arthroplasty (THA) revisions are loosening and instability. Use of a dual mobility cup cemented in a acetabular reconstruction cage device limits the risk of instability and does not hinder the acetabular fixation during THA revisions. The objective of this study was to analyze a retrospective series of 123 THA revisions with antiprotusio cage and dual mobility socket.
Method: Patients and methods: At a mean follow-up of 10 years, we analyzed a continuous series of 123 revisions using a reconstruction device (87 Kerboull cross-plates, 12 Burch-Schneider antiprotrusio cages, 24 custom-fit Novae ARM cages associated in all cases with a Novae Stick dual mobility cup cemented into the cage). There were 80 women and 43 males. The mean age at the surgery was 69.2 years old.

Results: PMA score increased from 9.6 ± 3.06 preoperatively to 14.2 ± 2. at the follow-up. 9 early dislocations occurred and one late dislocation. At the last follow-up, the X-rays showed nine hardware failures, including one cross-plate fracture, one hook fracture, and one flange fracture. Analysis of the radiological position of the cup showed a mean lowering of 13 mm and a 7 mm lateralization compared to the preoperative position. 2 revisions for aseptic loosening and 3 for septic loosening were performed.

Conclusion: This study confirms the advantage of dual mobility cups during acetabular reconstruction cemented in antiprotrusio cages as a way to limit, without eliminating, the risk of dislocation. Therefore cemented fixation of dual mobility cups in cages appears to be a reliable short-term option.

194 - Midterm Survival of Third Generation Wagner Femoral Revision Stems without Modularity
Étienne L Belzile, QC; Marc-Olivier Dion, QC; Michael Assayag, QC; Michèle Angers, QC; Stéphane Pelet, QC

Purpose: Modularity in femoral revision stems was developed to reduce subsidence, leg length discrepancy and dislocation experienced in revision surgery. The Wagner SL Revision Stem (Zimmer, Warsaw, IN) has been known for excellent bony fixation and proximal bony regeneration, but the third-generation proportional neck offset and 135° neck-shaft angle has an unknown track record. Our aim is to study the effect of these design modifications on stem subsidence, dislocation rate and stem survival.

Method: We reviewed 76 consecutive femoral revisions (70 patients; 50 M: 20 W; 67.7 yo [range; 37.7 - 86.6 yo]) with the Wagner SL implanted at our institution (2004-2012). No patient was lost to follow-up, but nine had died, and one patient was excluded for a Paprosky type I femoral bone defect. This leaves us 66 hips (60 patients) at 2 to 9.5 years of follow-up (mean 55 months; range, 24-114 months). Indications for revisions included aseptic stem loosening (62.1%), infection (13.6%), acetabular loosening (12.1%), recurrent dislocation (4.5%), periprosthetic (4.5%) and stem fracture (1.5%), and chondrolysis (1.5%). Patients were actively followed up at regular intervals to ascertain revision status and outcome measures including the Merle d’Aubigné (n=53), WOMAC questionnaires (n=59) and radiographs (n=66). Radiographs were evaluated for stem subsidence (mm).

Results: One of the surviving 66 stems was revised for recurrent deep infection (1.5%). No patient underwent revision of the femoral stem for aseptic loosening or subsidence. The mean preoperative WOMAC scores (P: 12.8; S: 5.6; F: 51.8) had improved significantly at follow-up (P: 9.7; S: 4.3; F: 37.6) (p<0.05). The mean Merle D’Aubigné score went from a pre-op of 8.2 (SD: 2.8; range 1 to 14) to a mean of 15.3 (SD: 2.6; range 7 to 18) (p<0.05) at the latest follow-up. During the follow-up period, 3 hips dislocated (4.5%). Each event happened prior to six months after surgery. Only one of these cases dislocated twice. Closed reduction was performed in all cases. None required revision surgery.
subsequently, and they all remained stable. The stem survivorship is 98.4% at 5 years (0.95 CI: 93-100) and 97.4% at 7.5 years (0.95 CI: 88.9-100). Stem subsidence of 0 to 5 mm was considered as not clinically significant (n=20; 30%). Stem subsidence of 5 to 10 mm occurred in 5 hips (7.6%) and stem subsidence greater than 10 mm only occurred in one hip (1.5%).

**Conclusion:** The third generation Wagner SL conical revision femoral stem has a lower rate of complication than its preceding generations, and is comparable to modular stems performance reported in current literature. These results motivate the authors to continue using monoblock conical revision femoral stems.

**195 - Porous Tantalum Uncemented Revision Acetabular Shells: Minimum 10 Year Clinical, Radiographic and Quality of Life Outcome**

*Nelson Greidanus, BC; Sujith Konan, BC; Clive Duncan, BC; Bas Masri, BC; Donald Garbuz, BC*

**Purpose:** In revision total hip arthroplasty (THA), acetabular reconstruction while dealing with severe bone loss is a challenge. The porous tantalum revision acetabular shells have been in use for the past decade. Several reports have documented successful use at early to mid-term follow up. There is, however, very little literature around the long-term survival and quality of life outcome with the use of these shells.

**Method:** We reviewed the results of 46 acetabular revisions with Paprosky 2 and 3 acetabular bone defects reconstructed with a hemispheric, tantalum acetabular shell and multiple supplementary screws. There were 31 females. Average age at revision was 64 years (range 23-85 years). The mean and median follow up was 11 years (range 10-12 years, SD 1). Morselized femoral allograft was used in 34 hips to fill contained cavitary defectes. Bulk femoral allografting was performed in 2 hips.

**Results:** At a minimum follow-up of 10 (range 10-12) years, the survivorship of the porous tantalum acetabular shell, with revision of the shell as end point was 96%. The minimum 10-year survivorship with hip revision for any reason as end point was 92%. We noted excellent pain relief (mean WOMAC pain 92.6) and good functional outcome (mean WOMAC function 90.3, mean UCLA 5); and generic quality of life measures (mean SF-12 physical component 48.3; mean SF-12 mental component 56.7). Patient satisfaction with pain relief, function and return to recreational activities were noted to be excellent.

**Conclusion:** Cementless acetabular revision with the tantalum acetabular shell demonstrated excellent clinical and quality of life outcomes at minimum 10-year follow-up. As far as we are aware this is the first report of minimum 10-year follow up of use of this technique for revision hip arthroplasty.

**196 - Complication Rate and Functional Outcome After Revision of MoM THA Related ARMD**

*Abdulaziz Almaawi, QC; Levent Bayam, England; Michael Duchesne-L’Heureux, QC; Daniel Lusignan, US; Martin Lavigne, QC; Pascal-André Vendittoli, QC*

**Purpose:** Management of pseudotumors associated with MoM THA can be difficult and complications are frequent. The functional outcome of patients after revision surgery may be suboptimal. The objective of this study was to assess our experience with revisions of failed MoM THA due to pseudotumors.
Method: 78 hips were diagnosed with pseudotumors in 70 patients following metal-on-metal hip replacements. Of these, 68 MoM THA were revised in 62 patients. Pre operative symptoms, radiographic analysis, metal ion levels, MRI results, intra-operative findings, WOMAC scores, the satisfaction level and the complication rate were recorded.

Results: Five patients had a resurfacing arthroplasty as their primary implants while the remaining 63 hips in 57 patients had MoM THA of different brands. The average time between the primary and revision surgery was 69 months (range 15-120). The average age at revision was 59 years (43-87). The mean follow-up was 24 months (range 2-73). 36 patients had minimal one year follow-up. Most lesions consisted of cystic changes and solid lesions were observed in 19 patients. In 57 hips, the pseudotumors were located posteriorly or postero-laterally around the greater trochanter. Intra operatively, muscle necrosis was observed in 15(22%) patients. Most THA cases demonstrated wear and corrosion at the head neck junction of the femoral implants. Thirty-five patients (44.9%) had greater than 50 degrees of cup abduction, including 10 patients (12.8%) with an abduction angle greater than 60 degrees. The average pre operative and postoperative Co ion levels were 27.46 ug/L (range 0.36-145.6) and 2.46 (range 0.4-12.48), respectively. Post revision, a total of 10 hips (14.7%) sustained a dislocation, with seven (10.3%) of them experiencing recurrent dislocations. In 8/10 hips, the femoral head size was 36mm or greater. Revision for dislocation occurred in seven(10.3%) patients. Three(4.4%) deep and one(1.47%) superficial infections occurred and deep infections were re-operated. One(1.47%) fracture of the greater trochanter and one (1.47%) psoas tendinitis did not need revision. Therefore, a total of 10 patients (14.7%) were reoperated. 6 revisions for instability were performed in the first 34 patients, while 1 were done in the last 34 patients. At one year post revision surgery, the mean WOMAC score was 19.68 (range 0-48). In comparison, the mean WOMAC score of the same patients one year after their primary surgery was 8.1 (0-63). Patient satisfaction level of patients one year post revision surgery was 7.61 (range 5-10) compared to 4.15 (range 0-7) pre-revision one.

Conclusion: The complication rate after revision of pseudotumors is high. Most revisions occurred secondary to instability despite the use of larger femoral heads. The functional outcome at one year post revision seems to be lower than that seen after primary THA but similar to other revisions in the literature. Experience in the management of these patients may reduce the complication rate.

197 - A Case-control Study of Total Hip Arthroplasty after Failed Proximal Femoral Fracture Fixation
Emil H Schemitsch, ON; David Walmsley, ON; Michael McKee, ON; Aaron Nauth, ON; James P Waddell, ON

Purpose: Proximal femur fractures are increasing in prevalence, with femoral neck (FN) and intertrochanteric (IT) fractures representing the majority of these injuries. The salvage procedure for failed open reduction internal fixation (ORIF) is often a conversion to total hip arthroplasty (THA). The use of THA for failed ORIF improves pain and function, however the procedure is more challenging. The aim of this study was to investigate the clinical and radiographic outcomes in patients who have undergone THA after ORIF.

Method: This retrospective case-control study compared patients who underwent THA after failed ORIF to a matched cohort undergoing primary THA for non-traumatic osteoarthritis. From 2004 to 2014, 40
patients were identified. The matched cohort was matched for date of operation, age, gender, and type of implant. Preoperative, intraoperative, and postoperative data were collected and statistical analysis was performed.

**Results:** The cohort of patients with a salvage THA included 18 male and 22 female patients with a mean age of 73 years and mean follow up of 3.1 years. Those with failed fixation included 12 IT fractures and 28 FN fractures. The mean time between ORIF and THA was 2.1 years for IT fractures and 8.5 years for FN fractures ($p=0.03$). The failed fixation group had longer procedures, greater drop in hemoglobin, and greater blood transfusion rate ($p<0.05$). There was one revision and one dislocation in the failed fixation group with no revisions or dislocations in the primary THA group. Length of admission, medical complications, and functional outcome as assessed with a standardized hip score and were found not to be statistically different between the groups.

**Conclusion:** Salvage THA for failed initial fixation of proximal femur fractures yields comparable clinical results to primary THA with an increased operative time, blood loss, and blood transfusion rate.

198 - Our Experience with a Recalled Hip Resurfacing Implant at a Minimum Five Year Follow-up
Nikolaos A Stavropoulos, QC; Laura M Epure, QC; David J Zukor, QC; Olga Huk, QC; John Antoniou, QC

**Purpose:** Hip resurfacing offers an attractive alternative to conventional total hip arthroplasty in young active patients. It is particularly advantageous for bone preservation for future revisions. Articular Surface Replacement (ASR) is a hip resurfacing prosthesis manufactured by DePuy Orthopaedics Inc. (Warsaw, IN). The manufacturer voluntarily recalled the ASR system in 2010 after an increasing number of product failures. The present study aimed to determine the long-term results in a large cohort of patients who received the ASR prosthesis.

**Method:** Between February 2004 and August 2010, 592 consecutive hip resurfacings using the ASR (DePuy Orthopaedics Inc., Warsaw, IN) resurfacing implant were performed in 496 patients (391 males and 105 females). The mean age of the patients at the time of the surgery was 54 (range: 25 to 74) years. Osteoarthritis was the most common diagnosis in 575 hips (97.1%). The remaining patients (2.9%) developed secondary degenerative disease from ankylosing spondylitis, avascular necrosis, developmental hip dysplasia, and rheumatoid arthritis. Clinical and radiographic information was available for all patients at the last follow up. Cobalt (Co) and chromium (Cr) levels were measured in 265 patients (298 hips) by inductively coupled plasma-mass spectrometry (ICP-MS).

**Results:** The average follow up of the study was 8.6 years (range: 5.2 to 11.6 years). The mean Harris hip and UCLA scores significantly improved from 44 and 2 pre-operatively to 85.3 and 7.1 respectively. The median Co and Cr ion level was 3.81 microgram per liter and 2.15 microgram per liter respectively. Twenty-seven patients (5.4%) were found to have blood levels of both Co and Cr ions that were greater than 7 microgram per liter. Fifty-four patients (9.1%) were revised to a total hip arthroplasty. Kaplan-Meier survival analysis showed a survival rate of 87.1% at 8.6 years with revision for any cause and 87.9% if infection is removed. A significantly higher survival rate was observed for the male patients (90.2%, $p<0.0001$) and for the patients with ASRs with femoral heads diameters larger than 52 mm (90.1%, $p=0.0003$).
Conclusion: This study confirms that patient selection criteria are of great importance to the overall survivorship of hip resurfacing arthroplasty. Improved clinical results have been reconfirmed with the use of larger diameter femoral heads.
199 - Do All Clavicle Fractures in Children Need to be Seen by an Orthopaedic Surgeon?
Mark W Camp, ON; John Adamich, ON; Andrew Howard, ON

Purpose: Although most uncomplicated paediatric fractures do not require routine long-term follow-up with an orthopaedic surgeon, practitioners with limited experience dealing with paediatrics fractures will often defer to a strategy of unnecessary frequent clinical and radiographic follow-up. Development of an evidence-based clinical care pathway may help reduce unnecessary radiation exposure to this patient population and reduce costs to patient families and the healthcare system.

Method: A retrospective analysis including patients who presented to SickKids hospital between October 2009 and October 2014 for management of clavicle fractures was performed. Patients with previous clavicle fractures, perinatal injury, multiple fractures, non-accidental injury, underlying bone disease, sternoclavicular dislocations, fractures of the medial clavicular physis and fractures that were managed at external hospitals were excluded from the analysis. Variables including age, gender, previous injury, fracture laterality, mechanism of injury, polytrauma, surgical intervention and complications and number of clinic visits were recorded for all patients. Radiographs were analyzed to determine the fracture location (medial, middle or lateral), type (simple or comminuted), displacement and shortening.

Results: 339 patients (226 males, 113 females) with an average age of 8.1 (range 0.1-17.8) were reviewed. Diagnoses of open fractures, skin tenting or neurovascular injury were rare, 0.6%, 4.1%, and 0%, respectively. 6 (1.8%) patients underwent surgical management. All decisions for surgery were made on the first consultation with the orthopaedic surgeon. For patients managed non-operatively, the mean number of clinic visits including initial consultation in the emergency department was 2.0 (±1.2). The mean number of radiology department appointments was 4.1 (± 1.0) where patients received a mean number of 4.2 (±2.9) radiographs. Complications in the non-operative group were minimal; 2 refractures in our series and no known cases of non-union. All patients achieved clinical and radiographic union and returned to sport after fracture healing.

Conclusion: Our series suggests that the decision to treat operatively is made at the initial assessment. If no surgical indications were present at the initial assessment by the primary-care physician, then routine clinical or radiographic follow up is unnecessary. Development of a paediatric clavicle fracture pathway may reduce patient radiation exposure and reduce costs incurred by the healthcare system and patients’ families without jeopardizing patient outcomes.

200 - Management of Displaced Supracondylar Fractures of the Humerus Using Lateral versus Cross K Wires: A Prospective Randomized Trial
Kishore Mulpuri, BC; Ashlee Dobbe, BC; Emily Schaeffer, BC; Firoz Miyanji, BC; Christine Alvarez, BC; Anthony Cooper, BC; Christopher Reilly, BC

Purpose: Closed reduction and percutaneous pinning has become the most common technique for the treatment of Type III displaced supracondylar humerus fractures in children. The purpose of this study
was to evaluate whether the loss of reduction in lateral K wiring is non-inferior to crossed K wiring in this procedure.

**Method:** A prospective randomized non-inferiority trial was conducted. Patients aged three to seven presenting to the Emergency Department with a diagnosis of Type III supracondylar humerus fracture were eligible for inclusion in the study. Consenting patients were block randomized into one of two groups based on wire configuration (lateral or crossed K wires). Surgical technique and post-operative management were standardized between the two groups. The primary outcome was loss of reduction, measured by the change in Baumann’s angle immediately post-operation compared to that at the time of K wire removal at three weeks. Secondary outcome data collected included Flynn’s elbow score, the humero-capitellar angle, and evidence of iatrogenic ulnar nerve injury. Data was analyzed using a t-test for independent means.

**Results:** A total of 52 patients were enrolled at baseline with 23 allocated to the lateral pinning group (44%) and 29 to the cross pinning group (56%). Six patients (5 crossed, 1 lateral) received a third wire and one patient (crossed) did not return for x-rays at pin removal and were therefore excluded from analysis. A total of 45 patients were subsequently analyzed (22 lateral and 23 crossed). The mean change in Baumann’s angle was 1.05 degrees, 95% CI [-0.29, 2.38] for the lateral group and 0.13 degrees, 95% CI [-1.30, 1.56] for the crossed group. There was no significant difference between the groups in change in Baumann’s Angle at the time of pin removal (p = 0.18). Two patients in the crossed group developed post-operative iatrogenic ulnar nerve injuries, while none were reported in the lateral group.

**Conclusion:** Preliminary analysis shows that loss of reduction in Baumann’s angle with lateral K wires is not inferior to crossed K wires in the management of Type III supracondylar humerus fractures in children. The results of this study suggest that orthopaedic surgeons who currently use crossed K wires could consider switching to lateral K wires in order to reduce the risk of iatrogenic ulnar nerve injuries without significantly compromising reduction.

**201 - Risk Factors for Complications in Open Forearm Fractures in the Paediatric Population**

Kevin Smit, ON; Adam Hines, US; Marilyn Elliott, US; Kevin Smit, ON; Dan Sucato, US; Robert Lane Wimberly, US; Anthony Riccio, US

**Purpose:** Infection and re-fracture are well-described complications following open paediatric forearm fractures. The purpose of this paper is to determine if patient, injury, and treatment characteristics can be used to predict the occurrence of these complications following the surgical management of paediatric open forearm fractures.

**Method:** This is an IRB-approved retrospective review at a single-institution paediatric level 1 trauma center from 2007-2013 of all open forearm fractures. Medical records were reviewed to determine the type of open fracture, time to administration of initial antibiotics, time from injury to surgery, type of fixation, length of immobilization, and complications. Radiographs were studied to document fracture characteristics.
Results: 262 patients with an average age of 9.7 years were reviewed. There were 219 Gustillo-
Anderson Type 1 open fractures, 39 Type 2 fractures, and 4 Type 3 fractures. There were 9 infections
(3.4%) and 6 re-fractures (2.3%). Twenty-eight (10.7%) patients returned to the operating room for
additional treatment; 21 of which were for removal of implants. Contaminated wounds, as documented
within the medical record, had a greater chance of infection (21% vs 2.2%, p=0.002). No difference in
infection rate was seen with regard to timing of antibiotics (p=0.87), timing to formal debridement
(p=0.20), Type 1 versus Type 2 or 3 open fractures (3.4% vs 5.0%, p =0.64), 24 hours vs. 48 hours of post-
operative IV antibiotics (5.2% vs 3.5%, p =0.53), or when comparing diaphyseal, distal, and Monteggia
fracture patterns (3.6 vs 2.9% vs 5.9%, p=0.81). There was no difference in infection rate when
comparing buried or exposed intramedullary implants (3.5% vs 4.2%, p>0.99). Rate of re-fracture was
not increased based on type of open wound (p>0.99) or fracture type (0.4973), although 5 of the 6 re-
fractures were in diaphyseal injuries.

Conclusion: In this series of open paediatric both bone forearm fractures, initial wound contamination
was a significant risk factor for subsequent infection. The rate of infection did not vary with timing of
antibiotics or surgery, type of open fracture, or length of post-operative antibiotics. A trend to higher re-
fracture rates in diaphyseal injuries was noted. Surgeons should consider planned repeat irrigation and
debridement for open forearm fractures with obviously contaminated wounds to reduce the
subsequent infection risk.

202 - Reliability of a Modified Complication Classification System in Paediatric Orthopaedic Patients

Rubini Pathy, ON; Emily Dodwell, US; Daniel W Green, US; David M Scher, US; John S Blanco, US;
Shevaun M Doyle, US; Aaron Daluiski, US; Ernest L Sink, US

Purpose: There is currently no standardized complication grading classification routinely used for
paediatric orthopaedic surgical procedures. The Clavien-Dindo classification used in general surgery was
modified and validated in 2011 by Sink et al. and has been used regularly to classify complications
following hip preservation surgery. The aim of this study was to adapt and validate Sink et al.’s
modification of the Clavien-Dindo classification system for grading complications following surgical
interventions of the upper and lower extremities and spine in paediatric orthopaedic patients.

Method: Sink et al.’s modification of the Clavien-Dindo classification system was further modified for
paediatric orthopaedic procedures. The modified grading scheme was based on the treatment required
to treat the complication and the long term morbidity of the complication.Grade I complications do not
require deviation from standard treatment. Grade II complications deviate from the normal post-
operative course and require outpatient treatment. Grade III complications require investigations, re-
admission or re-operation. Grade IV complications are limb or life threatening or have a potential for
permanent disability (IVA: with no long term disability and IVB: with long-term disability). Grade V
complications result in death. Forty-five complication scenarios were developed. Seven paediatric
orthopaedic surgeons were trained to use the modified system and they each graded the scenarios on
two occasions. The scenarios were presented in a different random order each time they were graded.
Fleiss’ and Cohen’s k statistics were performed to test for inter-rater and intra-rater reliabilities,
respectively.
Results: The overall Fleiss’ k value for inter-rater reliability was 0.772 (95% CI, 0.744-0.799). The weighted k was 0.765 (95% CI, 0.703-0.826) for Grade I, 0.692 (95% CI, 0.630-0.753) for Grade II, 0.733 (95% CI, 0.671-0.795) for Grade III, 0.657(95% CI, 0.595-0.719) for Grade IVa, 0.769 (95% CI, 0.707-0.83) for Grade IVb and 1.000 for Grade V (p value <0.001). The Cohen’s k value for intra-rater reliability was 0.918 (95% CI, 0.887-0.947). These tests show that the adapted classification system has high inter- and intra-rater reliabilities for grading complications following paediatric orthopaedic surgery.

Conclusion: Given the high intra- and inter-rater reliability and simplicity of this system, adoption of this grading scheme as a standard of reporting complications in paediatric orthopaedic surgery could be considered. Since the evaluation of surgical outcomes should include the ability to reliably grade surgical complications, this reproducible, reliable system to assess paediatric surgical complications will be a valuable tool for improving surgical practices and patient outcomes.

203 - Differences in EMG Stimulation Thresholds at the Apical Pedicle in Paediatric Spine Deformity Correction
Katie Rooks, SK; Heather Hansen, SK; Jonathan Norton, SK; Anne Dzus, SK; Lauren Allen, SK; Douglas Hedden, AB

Purpose: The evolution of operative technology has allowed correction of complex spinal deformities. Neurological deficits following spinal instrumentation is a devastating complication and the risk is especially high in those with complex sagittal and coronal plane deformities. Prior to intraoperative evoked potential monitoring, spinal cord function was tested using the Stagnara Wake up test, typically performed after instrumentation once the desired correction has been achieved. This test is limited as it does not reflect the timeframe in which the problem occurred and it may be dangerous to some patients. Intraoperative neuromonitoring allows timely feedback of the effect of instrumentation and curve correction on the spinal cord. Pedicle screws that are malpositioned can result in poor fixation or neuronal injury. Evoked EMG monitoring can aid in accurate placement. A positive EMG response can alert the surgeon to a potential pedicle breech and allow them to reassess the placement of their hardware intraoperatively. The stimulation threshold is affected by the amount of surrounding bone acting as an insulator to electrical conduction and is variable in different regions of the spine. In the non-deformed, lumbar spine stimulation thresholds have been established. Such guidelines have not been well-developed for the thoracic spine, or for severely scoliotic spines. Thus our primary objective was to compare the stimulation threshold of the apical pedicle on the concave side to the stimulation threshold of the pedicles at the upper and lower instrumented levels.

Method: Intraoperative EMG stimulation thresholds were done at 192 apical pedicles on the concave side of the deformity and then compared to those thresholds found at 169 terminal level pedicles. Only pedicles for which a stimulation threshold was found were reported and excluded those where a breech was suspected. The lowest stimulation required for an EMG response was documented to a maximum stimulation of 20 mA.

Results: The mean threshold at the apex was 16.62 milliamps (mA) compared to 18.25mA at the terminal levels. This was compared with the t-test and showed a statistically significant difference (p<0.05).
Conclusion: In this study we report only the thresholds for the concave side, the pedicle that is most likely to be reduced in size. The threshold for stimulation is reduced compared to those seen at the highest and lowest instrumented level. Most of the apexes are located in the mid-thoracic spine with the highest instrumented levels being in the high thoracic spine and the lowest levels being in the lumbar spine. This study provides preliminary evidence that the apical, concave pedicle has a lower threshold than the end pedicles and one cannot rely on established thresholds from different areas of the spine. The surgeon should be cognizant of these differences when instrumenting at the apical level. Ongoing work is examining the convex apex threshold as well as the relationship between the effect of age and a diagnosis other than adolescent idiopathic scoliosis.

204 - The Effect of Lateral Spine Curvature on Somatosensory Evoked Potentials in Patients with Adolescent Idiopathic Scoliosis
J Alexandra Mortimer, SK; Jonathan Norton, SK; Anne Dzus, SK; Lauren Allen, SK

Purpose: To examine the effect of lateral spine curvature on somatosensory evoked potentials (SSEP) in patients with adolescent idiopathic scoliosis (AIS) compared to normal controls. We hypothesize that patients with AIS will show increased latency in their SSEPs when bending into their curve suggesting that their spinal cord is more sensitive to this increased lateral curvature.

Method: Patients were recruited from the paediatric scoliosis clinic in a single centre. Inclusion criteria were: diagnosis of AIS, age 10-18 years, major thoracic curve measuring greater than 10 degrees on Cobb measurement, and undergoing nonoperative management. Exclusion criteria were: any detectable neurologic deficit, and previous surgery on the brain or spine. SSEP recordings were obtained via stimulation of the posterior tibial nerve with surface electrode and measurement of the cortical response over the scalp. All recordings were performed three times: with the patient in neutral standing and maximum right and left side bending.

Results: SSEP recordings show that when AIS subjects bend into their curve, latency slows by an average of 0.5ms. However there was a bimodal distribution with most subjects showing minimal change (3ms). This subset was statistically different from both a control group, and the larger AIS group.

Conclusion: There appears to be a subset of patients with AIS who have subclinical spinal cord dysfunction demonstrated by abnormal SSEPs. This may place these patients at slightly higher risk of neurologic injury at the time of surgery.

205 - VEPTR Implantation to Treat Children with Early Onset Scoliosis without Rib Abnormalities: A Prospective Multicenter Study
Muayad Kadhim, NS; Ron El-Hawary, NS; Michael Vitale, US; John Smith, US; Amer Samdani, US; John (Jack) Flynn, US; Children's Spine Study Group, US

Purpose: To evaluate the efficacy of VEPTR in preventing further progression of scoliosis without impeding spinal growth in the treatment of children with progressive early onset scoliosis (EOS) without rib abnormalities.
Method: Prospective, multi-center, observational cohort study on patients with EOS treated with VEPTR with 2-year follow up. Data were analyzed based on measurements done pre-implant, immediate post-op and at 2-yr f/u.

Results: Sixty-three patients met inclusion: 35 males and 28 females. Mean age at time of implantation was 6.1±2.4 yrs. Etiologies included congenital (n=6), neuromuscular (n=36), syndromic (n=4), and idiopathic (n=17). Mean follow up was 2.2±0.4 yrs. Scoliosis (72°±18°) decreased after implant surgery (47°±17°) followed by slight increase at 2-yr f/u (57°±18°), p<0.0001.

Conclusion: At 2-yr f/u, VEPTR was effective in treating EOS without rib abnormalities with 86% of patients having an improvement in scoliosis and 94% of patients having an increased spinal height as compared to pre-operatively. VEPTR provided greater than 100% of expected age-matched spine growth and the instrumented spinal segment continued to grow during distraction phase. This large prospective, multi-center study demonstrated the ability of VEPTR to effectively treat EOS without rib abnormalities. Goals of preventing further scoliosis progression and of maintaining normal spine growth were achieved.

206 - Reducing Cost and Radiation Exposure During the Non-operative Treatment of Paediatric Proximal Humerus Fractures
Mark Camp, ON; Aharon Z Gladstein, US; Alexander Shade, England; Andrew Howard, ON

Purpose: The primary objective of this study was to determine if paediatric proximal humerus fractures undergo significant displacement resulting in change in management.

Method: A retrospective analysis was performed on children who presented with proximal humeral fractures to our institution between 2009 and 2014. Patients were included if they were diagnosed with a fracture of the proximal humerus in the absence of an underlying bone cyst or pathological condition. Patients with open fractures, multiple fractures, neurologic, or vascular injuries were excluded. The primary endpoint was conversion to operative treatment after initial non-operative management. Secondary endpoints were a healed fracture with acceptable alignment at the final radiographic evaluation, as well as the number of follow-up radiographs obtained after the initiation of non-operative management.

Results: A decision to manage the fracture operatively at the initial presentation was made in 14 out of 239 patients. Of the 225 patients that were initially managed non-operatively, only 1 patient underwent subsequent surgical management. In this series, no non-unions, re-fractures, nor fracture-dislocations were identified.

Conclusion: These data support that the majority of management decisions for paediatric proximal humeral fractures are made at the initial presentation. Once non-operative management is chosen, routine follow-up imaging rarely leads to any change in treatment.

207 - Evaluation of Primary Caregivers’ Perceptions on Home Trampoline Use
Supriya Singh, ON; Debra Bartley, ON; Megan Cashin, ON; Timothy Carey, ON; Kamary Coriolano DaSilva, ON
Purpose: The objectives of this study are to ascertain primary caregivers' understanding of risks associated with home trampoline use; to educate caregivers in regard to documented literature based risks associated with home trampoline use; and to evaluate if this information will have any influence on their future regulation of home trampoline use for their children.

Method: One hundred primary caregivers of patients treated in the paediatric orthopaedic surgery outpatient clinic at London Health Sciences center were surveyed. All caregivers in clinic were invited to participate. The only exclusion criteria was the inability to provide consent. Caregivers’ baseline perceptions on the risks associated with home trampoline use were assessed using a questionnaire. Caregivers then received an information pamphlet outlining documented trampoline safety data. They were then sent the same questionnaire to complete within one week of reading the pamphlet. Using our research electronic database capture (Redcap), the results of the surveys were compiled and analyzed using spss 22, paired t-test and repeated measures anova. A sample size of 55 was calculated to result in a power of 80%.

Results: Of primary caregivers surveyed, 36% owned a home trampoline, and only 5% had personal experiences with their child sustaining a trampoline injury. Pre-education, when caregivers were asked on a scale of one (not dangerous) to 10 (very dangerous) how dangerous they felt a trampoline was for their child, the average response was six. Post-education, this number changed to eight. Providing education to primary caregivers significantly changed their perceptions on all sections of the questionnaire, yet 47% of primary caregivers were willing to allow their child to use a trampoline at home despite their new understanding of trampoline injury and safety.

Conclusion: Providing education to primary caregivers significantly changed their perceptions on all trampoline safety questions, indicating effective comprehension. Despite caregivers’ understanding of the risks associated with home trampoline use, approximately half of the study population continue to permit this activity for their children. There is potential to reduce paediatric orthopaedic injuries associated with home trampoline use if safer trampoline related practices are implemented based on information provided.

208 - The Heterogeneous Management of Paediatric Ankle Sprains: A Single Center Experience
Reuban James Moore, QC; Philippe Voizard, QC; Marie-Lyne Nault, QC

Purpose: Ankle sprains are common athletic injuries, with a peak lifetime incidence between the ages of 15 and 19 years, especially in young males. However, an unclear history, an imprecise physical exam, and unhelpful radiographies lead to frequent misdiagnosis of paediatric ankle traumas, and subsequently, inappropriate treatment. Improper management may lead to residual pain, instability, slower return to physical activity, and long-term degenerative changes. The purpose of this study was to evaluate the initial management and treatment of acute paediatric ankle sprains at our center, a tertiary care paediatric hospital. Our hypothesis was that the initial diagnosis is often incorrect, and treatment varies considerably amongst orthopaedic surgeons.

Method: We conducted a retrospective study of all cases of ankle sprains and Salter-Harris one (SH1) fractures referred to our orthopaedic surgery service between May and August 2014. Exclusion criteria
included ankle fractures other than SH1 types, and cases where treatment was initially undertaken elsewhere before referral to our service. Patients were evaluated on a clinical and radiographic basis. Primary outcome was the difference between initial and final diagnosis. Secondary outcome was variation in immobilization duration for each diagnosis. The main variables we considered were age, sex, mechanism of trauma, referral delay, patient symptoms, physical exam findings, radiographic findings, type and duration of immobilization, prescription of any medication, and referral to physical therapy.

**Results:** A total of 3047 patients were reviewed and 31 cases matched our inclusion criteria, comprised of 17 girls and 14 boys, with a mean age of 10.4 years. Patients were seen at a mean of 10.3 days after injury. Initial diagnosis was SH1 fracture in 20 cases, acute ankle sprain in 8 cases, and uncertain in 3 cases. Final diagnosis was SH1 fracture in 11 cases, acute ankle sprain in 13 cases, uncertain in 5 cases, and other in 3 cases. During follow up, 48.5% of cases saw a change in diagnosis. Forty five percent (9/20) of cases initially diagnosed as SH1 fractures proved to be incorrect, with 55.5% (5/9) of these being ultimately diagnosed as acute ankle sprains. Amongst cases initially diagnosed as acute ankle sprains, 37.5% (3/8) received a different final diagnosis. Duration of immobilization was significantly different between acute ankle sprain and SH1 fracture groups, with an average of 17.3 days and 26.1 days, respectively. Physical therapy was prescribed to 33.3% of acute ankle sprains and 9.1% of SH1 fractures.

**Conclusion:** Initial distinction between acute ankle sprains and SH1 fractures can be difficult in paediatric ankle trauma. Case management and specific treatments vary considerably, as there is neither an evaluation algorithm nor consensus on treatment of these paediatric pathologies. This study reinforces the need to develop a systematic diagnostic and treatment protocol for paediatric ankle sprains.