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1 - Endothelial Progenitor Cells for Healing of Segmental Bone Defects: A Radiographic, MicroCT, and Biomechanical Study in Rats
Ru Li, ON; Kivanc Atesok, ON; David Wright, ON; Aaron Nauth, ON; Cari M Whyne, ON; Emil H Schemitsch, ON;

Purpose: Severe fractures damage blood vessels and disrupt circulation at the fracture site resulting in an increased risk of poor fracture healing. Endothelial progenitor cells (EPCs) are bone-marrow derived cells with the ability to differentiate into endothelial cells and contribute to neovascularization and re-endothelialization after tissue injury and ischemia. We have previously reported that EPC therapy resulted in improved radiographic healing and histological blood vessel formation in a rat fracture model. The purpose of this study was to further quantify the effects of EPC therapy with microCT and biomechanical analyses.

Method: Five-millimeter segmental defects were created and stabilized in the femora of 14 fisher 344 rats. The treatment group (n=7) received 1x106 EPCs within gel-foam locally at the area of the bone defect and control animals (n=7) received only saline-gelfoam with no cells. The formation and healing of bone after 10 weeks were assessed by radiographic, micro-CT and biomechanical analyses.

Results: Radiographically all the animals in EPC-treated group healed with bridging callus formation, whereas control group animals demonstrated radiographic non-union. Micro-CT assessment demonstrated significantly improved parameters of bone volume (35.34 to 20.68 mm³; p=0.000), bone volume density (0.24 to 0.13%, p=0.001), connectivity density (25.13 to 6.15%, p=0.030), trabecular number (1.14 to 0.51 /mm, p=0.000), trabecular thickness (0.21 to 0.26 mm, p=0.011), trabecular spacing (0.71 to 1.88 mm, p=0.002), bone surface area (353.85 to 159.43/mm, p=0.000), and bone surface to bone volume ratio (9.43 to 7.82 /mm, p=0.013) in the defect site for the EPC group versus the control group respectively. Biomechanical testing showed that the EPC treatment group had a significantly higher torsional strength compared with the control group (EPC=164.6±27.9 Nmm, Control=29.5±3.8 Nmm; p value = 0.000). Similarly, the EPC treated fractures demonstrated significantly higher torsional stiffness versus controls (EPC=30.3±5.0 Nmm/deg, Control=0.9±0.1 Nmm/deg; p value = 0.000). When biomechanically compared to contralateral intact limbs, the EPC treated limbs had similar torsional stiffness (p=0.996), but significantly lower torsional strength (p=0.000) and smaller angle of twist (p=0.002).

Conclusion: These results suggest that local EPC therapy significantly enhances fracture healing in an animal model. The biomechanical results show that control animals develop a mechanically unstable non-union. In contrast, EPC therapy results in fracture healing that restores the biomechanical properties of the fractured bone closer to that of intact bone.

2 - Human Mast Cell Effects on Collagen Gel Contraction by Human Elbow Capsule Cells
Kevin A Hildebrand, AB; Mei Zhang, AB; Paul T Salo, AB; David A Hart, AB;

Purpose: The objective of the present study was to determine whether human mast cells can modify behavior of human elbow contracture capsule cells in an in vitro collagen gel contraction assay.

Method: Posterior elbow joint capsule was obtained from a 38 year old man with a chronic (> 1 year) post-traumatic joint contracture. Joint capsule cells were isolated and suspended at a density of 2.5 x 105 cells/ml, and mixed with neutralized Collagen solution composed with 58% Vitrogen 100 purified collagen. Aliquots of collagen gel without cells, with only the human mast cell line, HMC-1 (2.5 x 105), human capsule cells (2.5 x 105), human capsule cells (2.5 x 105) and an equal number of mast cells (1:1), or human capsule cells (2.5 x 105) and 7.5 x 105 mast cells (1:3) were then cast into wells tissue culture plate. The gels were maintained with 0.5 ml DMEM composed with 2% BSA and incubated at 37°C for 12 h for gelation to occur. After 12 hr initial culture, the gels were detached from the wall and the bottom of culture plate wells, and gel area was determined at 0h, 2h, 4h, 6h, 24h, 48h, and 72h. Gel contraction studies were carried out on passage 6 and done in triplicate. The blocking assay to inhibit mast cell - joint capsule cell interaction employed antibodies to Stem Cell Factor (SCF) and c-kit. SCF (0.5, 1 or 10 microg/ml) and/or c-kit (0.05, 0.1 or 1 microg/ml) were added individually or in combination (SCF 10 microg/ml and c-kit 1 microg/ml only) to cells/collagen gel mixture before gel casting. The ratio of human capsule cells and HMC-1 was kept constant at 1:3 throughout the experiment. The inhibitory effect of SCF and c-kit antibodies on collagen gel contraction induced by human capsule cells and HMC-1 was expressed in percentage of gel areas at 24h post release. Inhibition effect (%) = 100% - [(gel size – c-kit or SCF gel size)/(blank gel size – JC:M gel size)x 100%]. Statistical analysis involved an ANOVA with posthoc Bonferroni correction. P < 0.001 was significant. Data are mean ± standard deviation.

Results: Joint capsule cells were able to contract collagen gels in a time-dependent manner. This contraction was significantly enhanced in the presence of the HMC-1 cells in a dose dependent fashion (p < 0.001). HMC-1 cells were unable to contract the collagen gels by themselves. Experiments with antibodies to the mast cell – fibroblast direct cell-cell communication determinants SCF or c-kit showed inhibition of the enhanced contraction at 24 hours between 43 – 72%. Combining the highest dose of SCF and c-kit led to 82% inhibition.

Conclusion: This study has shown that cells isolated from human elbow joint contracture capsules respond to mast cells in a collagen gel assay in a dose dependent manner. This study is consistent with our previous work which has shown that ketotifen, a mast cell stabilizer that prevents mast cell degranulation and liberation of factors, can reduce contracture severity in a rabbit model of post-traumatic joint contractures.

3 - Anterior vs Posterior Triceps Repair Following Olecranon Excision: Effects on Stability and Strength on an in vitro Model
**Louis M Ferreira**, ON; **Timothy H Bell**, ON; **James Andrew Johnson**, ON; **Graham J King**, ON;

**Purpose**: Most displaced olecranon fractures can be treated with ORIF. However with severe comminution or bone loss, excision of the fragments and repair of the triceps to the ulna is recommended. The triceps can be reattached to either the anterior or posterior aspect of the ulna. The purpose of this in-vitro study was to determine the effect of triceps repair technique on elbow laxity and extension strength in the setting of olecranon deficiency.

**Method**: Eight unpreserved cadaveric arms were used (age 75 ± 11 years). Surface models were generated from CT images and sequential olecranon resections in 25% increments were performed using real-time navigation. Muscle tendons (biceps, brachialis, brachioradialis and triceps) were sutured to actuators of an elbow motion simulator, which produced active extension. A tracking system recorded kinematics in the varus and valgus positions. A triceps advancement was performed using either an anterior or posterior repair to the remaining olecranon in random order. Triceps extension strength was measured in the dependent position with the elbow flexed 90° using a force transducer located at the distal ulnar styloid, while triceps tension was increased from 25-200 N. Outcome variables included maximum varus-valgus elbow laxity and triceps extension strength. Two-way repeated measures ANOVAs were performed for laxity comparing resection level and repair method. Three-way repeated measures ANOVAs were performed for triceps extension strength comparing triceps tension, resection level and repair method. Significance was set at p < 0.05.

**Results**: Progressive olecranon resection increased elbow laxity (p < 0.001). Although the posterior repair produced slightly greater laxity for all but the 50% resection, this difference was not significant (p = 0.2). The posterior repair provided greater extension strength than the anterior repair at all applied triceps tensions and for all olecranon resections (p = 0.01). The initial 0% resection reduced extension strength for both repairs (p < 0.01), however, there was no effect of progressive olecranon resections (p = 0.09).

**Conclusion**: There was no significant difference in laxity between the anterior and posterior repairs. Thus even for large olecranon resections, the technique of triceps repair does not have significant influence on joint stability. Extension strength was not reduced by progressive olecranon resections, perhaps due to wrapping of the triceps tendon around the trochlea putting it in-line with the ulna and giving it a constant moment arm. Triceps extension strength was higher for the posterior repair. This is likely due to the greater distance and hence moment arm of the posterior repair to the joint rotation center. Conversely, the anterior repair brings the triceps insertion closer to the joint center, reducing the moment arm. Since there was no significant difference in laxity between the repairs, the authors favour the posterior repair due to its significantly higher triceps extension strength.

**4 - Synergistic Effect of rhBMP-7 and Osteogenic Differentiation Medium on Human Bone Marrow-derived Primary Mesenchymal Stem Cells in vitro**

**Chao Chen**, AB; **Lianteng Zhi**, AB; **Xiaoai Pang**, AB; **Hasan Uludag**, AB; **Hongxing Jiang**, AB;

**Purpose**: The current clinical treatment protocol for bone healing applies super-physiological dose of rhBMP7. Unfortunately, it may result in adverse side effects. Some studies have demonstrated a dose-dependent osteogenic differentiation using rodent bone marrow derived stem cells (BMSCs). However, the dose effect of BMP7 on osteogenic differentiation of normal human BMSCs is largely unknown. In the present study, we investigated in vitro osteogenic differentiation of hBMSCs with a gradient concentration of rhBMP7. The interaction between rhBMP7 and osteogenic differentiation medium (ODM) was also examined.

**Method**: The primary BMSCs from human bone marrow were cultured and maintained in MSC growth medium (MGM). Six study groups were designed: MGM only, MGM with rhBMP7 of 0.1ug/ml, ODM only, and ODM with 3 concentration of rhBMP7 of 0.01µg/ml, 0.1µg/ml, and 1.0µg/ml, respectively. Alkaline phosphatase level (ALP) at day 17 and cumulative calcium deposit at both day 1 and day 35 were examined. mRNA expression level of osteogenic markers including osteocalcin (OC), osteopontin (OPN) and ALP were quantified using real-time RT-PCR at day 17.

**Results**: ALP activity at day 17 did not increase in MGM with or without 0.1µg/ml of rhBMP7, ODM alone and ODM with 0.01µg/ml of rhBMP7. ALP activity was much higher with 0.1µg/ml of rhBMP7 plus ODM (0.22±0.02IU) than that in MGM with 0.1µg/ml of rhBMP7 (0.01±0.01IU, P<0.05).

**Conclusion**: Our study demonstrated that rhBMP7 induced osteogenic differentiation of hBMSCs in a dose-dependent manner in the presence of ODM and the minimal dose for inducing in vitro osteoblastic differentiation was 0.1ug/ml of rhBMP7 under synergistic effect of ODM. The results of this study provide some insights into further investigation of synergy of rhBMP7 with other molecules. The types and amounts of simple molecules could significantly reduce therapeutic dose of rhBMP7 and achieve equivalent or better outcomes in clinical application warrant further investigation.

**5- Endothelial Progenitor Cells for Healing and Angiogenesis in a Segmental Bone Defect Model: A Comparison with Mesenchymal Stem Cells**

**Aaron Nauth**, ON; **Emil H Schemitsch**, ON; **Ru Li**, ON;

**Purpose**: The purpose of this study was to compare the effects of two types of stem/progenitor cells on the healing of critical sized bone defects in a rat model. Endothelial Progenitor Cells (EPCs), a novel cell type with previously demonstrated effects on angiogenesis in animal models of vascular disease, were compared to both a control group of no cell therapy, and a treatment group of Mesenchymal Stem Cells (MSCs). The hypothesis was that EPCs would demonstrate both superior bone healing and angiogenesis, when compared to the control group and MSC group.

**Method**: EPCs and MSCs were isolated from the bone marrow of syngeneic rats by differential culture and grown ex vivo for 10 days. Subsequently the cells were harvested, seeded on a gelfoam scaffold, and implanted into a 5mm segmental defect in a rat femur that
had been stabilized with a plate and screws. Bone healing was assessed radiographically and by microCT. Angiogenesis was assessed by histology and physiologically, using laser doppler to assess blood flow in the bone and soft tissues. All animal protocols were approved by and performed in accordance with the St. Michael’s Hospital Animal Care Committee. ANOVA was used to test for significant differences between the groups, and a p-value of <0.05 was considered statistically significant.

**Results:** The EPC (n=14) group demonstrated radiographic evidence of healing of the bone defect as early as 2 weeks, and all specimens were radiographically healed at 6 weeks. Both the control group (n=14) and the MSC group (n=14) showed no radiographic evidence of healing at 10 weeks. MicroCT comparison of the EPC group versus the control group showed significantly greater bone volume and density at the defect site (p<0.001). More blood vessel formation was observed in the EPC group versus the control group on histology at 2 weeks. Laser Doppler assessment showed significantly more soft tissue and bone blood flow at 2 and 3 weeks in the EPC group versus the control group (p=0.021).

**Conclusion:** The results of this study demonstrate that EPCs are effective as cell-based therapy for healing critical sized bone defects in a rat model. In this model EPCs demonstrated superior angiogenesis over controls in a rat model of fracture healing. These results strongly suggest that EPCs are effective for therapeutic angiogenesis and osteogenesis in fracture healing. There is a clinical need for effective strategies in the management of traumatic bone defects and non-unions. Investigation into the use of MSCs as an effective alternative to autologous bone grafting has failed to translate into clinical use. It is possible that EPCs are more effective at the regeneration of bone in segmental defects because of their synergistic effect on angiogenesis and osteogenesis. Further research into EPC based therapies for fracture healing is warranted.

6 - Dynamic MR Imaging with Concurrent Physical Examination in Evaluation of Knee MCL Injuries

**Christopher R Geddes,** ON; Ulrich Studler, ON; Melanie Deslandes, ON; Lawrence White, ON; Marshall Sussman, ON; John Theodoropoulos, ON;

**Purpose:** In evaluating injury severity of acute medial collateral ligament (MCL) injuries, the current standard is to perform a history and physical examination and static MRI of the injured joint. With recent advances in dynamic MR imaging technology, we hypothesized that concurrent physical examination and dynamic MRI of the knee joint in patients with acute MCL injuries is feasible and would provide new insight into the injured joint kinematics while correlating to clinical and diagnostic imaging criteria for injury severity.

**Method:** 10 patients (5 male, 5 female) with isolated, unilateral, acute MCL injuries were prospectively enrolled in the study. An orthopedic surgeon performed initial physical examination and clinical grading. Dynamic MRI with concurrent physical examination was performed in a 1.5T wide-bore magnet and compared to the uninjured knee as a control. The dynamic MR imaging data was compared with morphologic MRI changes on static MRI, with dynamic examination of the contralateral knee and with the clinical grading of MCL injury. The width of the medial joint space and the opening angle between the femur and tibia were measured.

**Results:** Clinically, one patient had grade 1 and nine had grade 2 injuries. Using morphologic MRI criteria there were nine grade 2 and one grade 3 injuries. Mean and median medial opening angles of all affected knees was 2.8/2.5 mm and 2.8/2.6°, respectively, as compared to 1.8/1.8 mm and 2.2/2.1° in the normal side. Measurements of medial joint-space opening showed little quantitative difference between grade 1, 2 and 3 injuries. Interobserver agreement (intraclass correlation coefficients) varied from 0.9 to 0.93.

**Conclusion:** Dynamic MR imaging with concurrent physical examination is feasible and correlates to clinical and morphologic grading of severity. Our study suggests that traditional clinical grading systems of MCL injuries overestimate medial joint space opening.

7 - Suppressed Osteogenic Effect of BMP2 to Human Mesenchymal Stem Cells by Macrophages

**Chao Chen,** AB; Hasan Uludag, AB; Alex Rezansoff, AB; Hongxing Jiang, AB;

**Purpose:** The osteogenic effects of BMPs on mesenchymal stem cells (MSCs) are less profound in human as compared to rodent. The mechanism for this phenomenon is unclear. This study evaluated the effects of macrophages on proliferation and BMP-2 induced osteogenic differentiation of human MSCs.

**Method:** MSCs were isolated from human bone marrow. Human monocytes THP-1 (human acute monocytic leukemia cell line) were induced into macrophages by phorbol myristate acetate. The conditioned media (CM) from monocytes and macrophages were collected separately. After treated with CM from monocytes or macrophages for 5 and 7 days, the proliferation rate of human MSCs was determined by WST-8 assay. A group without CM served as control. Pretreated human MSCs were then induced towards osteogenic differentiation by osteoinductive medium supplemented with 0.1ug/ml BMP-2. Expression levels of osteogenic markers were determined by real-time quantitative PCR. Alkaline phosphatase (ALP) activity and mineral deposition were assessed by p-NPP colorimetric kinetic assay and calcium assay, respectively.

**Results:** The number of MSCs was significantly decreased in the group with macrophage CM at both 5 and 7 days (both p<0.001) as compared with control group, but not in the group with monocytes CM. Expression levels of ALP and bone sialoprotein 2 in the macrophage CM group were significantly lower than those in the control group (p=0.003 and p<0.001, respectively). ALP activity was also significantly lower in the group with macrophage CM than control group (p<0.001). Although the expression levels of osteocalcin and RUNX2 as well as calcium deposition in the macrophage CM group were reduced, they did not reach statistical significance.

**Conclusion:** Macrophages suppressed the proliferation of MSCs and inhibited BMP-2 induced osteogenic differentiation of human MSCs. In addition to known BMP antagonists, macrophages might be another important factor in suppressing the osteogenic effect of BMP-2 on human MSCs.
8 - The Measurement of Tension in the Medial Collateral Ligament of the Elbow
Louis M Ferreira, ON; Katherine E Fay, ON; Emily A Lalone, ON; James A Johnson, ON; Graham J King, ON;

**Purpose:** Techniques to quantify soft-tissue forces in the upper extremity are not well described. Consequently, ligament forces of the elbow joint have not been reported. Knowledge of the magnitudes of tension of the primary valgus stabilizer, the anterior bundle of the medial collateral ligament (AMCL), would allow for an improved understanding of the load borne by the ligament. The purpose of this in vitro study was to quantify the magnitude of tension in the native AMCL throughout flexion with the arm in the valgus orientation. We hypothesized that tension in the AMCL would increase with flexion.

**Method:** Five fresh-frozen cadaveric upper extremities (mean age 72 ± 10 years) were tested. To produce active muscle loading in a motion simulator, cables were affixed to the distal tendons of the brachialis, biceps brachii, triceps brachii, and brachioradialis and attached to actuators. The wrist was fixed in neutral flexion/extension and the forearm in neutral rotation. The arm was orientated in the valgus gravity-loaded position. A custom designed ligament load transducer was inserted into the AMCL. Active simulated flexion was achieved via computer-controlled actuation while passive elbow flexion was achieved by an investigator manually guiding the arm through flexion. Motion of the ulna relative to the humerus was measured using a tracking device.

**Results:** Both the active and passive motion pathways showed an increase in AMCL tension with increasing angles of elbow flexion (p < 0.05). There was no difference in AMCL tension levels between active and passive elbow flexion (p = 0.20). The mean maximum tension achieved was 97±33 N and 94±40 N for active and passive testing respectively.

**Conclusion:** AMCL tension levels were observed to increase with elbow flexion, indicating that other structures (such as the joint capsule and the shape of the articulation) are likely more responsible for joint stability near full extension, and that the AMCL is recruited at increased angles of elbow flexion. With respect to load magnitudes, Regan et al. found the maximum load to failure of the AMCL was 261 N, while Armstrong et al. reported a failure load of 143 N in cyclic testing. The maximum AMCL tension level observed in this study was 160 N. Failure of the AMCL was not observed, which may be due to differences in specimen size, age, or the method of load application. In summary, this in vitro cadaveric study has provided a new understanding of the magnitudes of AMCL tension through the arc of elbow flexion, and this has important implications with respect to the desired target strength of repair and reconstruction techniques. These findings will also assist in the development and validation of computational models of the elbow.

9 - Rodent Model of Adult Stem Cell Transplantation for Bone Repair
Chan Gao, QC; Oliver Nguyen, QC; Vahid Serpooshan, QC; Bilal Eichaarani, QC; Showan N Nazhat, QC; Edward J Harvey, QC; Janet E Henderson, QC;

**Purpose:** Poor bone quality is a common challenge to orthopaedic surgeons and frequently leads to complications such as non union and implant failure, particularly the elderly whose capacity for tissue repair is significantly reduced. The current study was designed to determine if bone marrow derived mesenchymal stem cells (MSC) seeded in dense collagen scaffolds and delivered to a surgically-induced femoral defect will expedite bone healing.

**Method:** Ex Vivo: MSC isolated from four month old donor mice were expanded ex vivo, seeded into hydrated type I collagen, which was subjected to unconfined compression to generate dense collagen scaffolds. The cell-seeded scaffolds were then cultured for up to 21 days. MSC viability was monitored using the AlamarBlue® metabolic assay and differentiation into osteoblasts using alkaline phosphatase (ALP) and von Kossa stain. In Vivo: A 3mm x 1mm window defect was drilled in the femur of elderly recipient C57Bl6 and C3H mice. The C3H mice were assigned to one of two study groups: 1) LEFT femur drill hole alone; RIGHT femur acellular scaffold. 2) LEFT femur acellular scaffold; RIGHT femur cell-seeded scaffold. The quantity and quality of bone regeneration was assessed after 2 and 4 weeks using micro computed tomography (mCT) and histology.

**Results:** Ex Vivo: The dense collagen scaffold had superior mechanical properties and supported the survival and differentiation of MSC into osteoblasts up to 21 days in culture. Cells in uncompressed gels and those in compressed gels in non-osteogenic medium, had fewer ALP-positive cells at early time point and less mineral deposited at later times compared with those in compressed gels in osteogenic medium. In Vivo: A high incidence of postoperative fracture was seen in C57Bl6 mice compared with age matched C3H mice in the first study group. Furthermore, the empty surgical defect healed more rapidly than that containing the dense collagen scaffold, in which bone volume compared with tissue volume (BV/TV), trabecular number (Tb.N.) and connectivity were lower. In study group two, bone regeneration was evident at 2 weeks post operative and transplantation of MSC-seeded dense collagen scaffolds resulted in higher BV/TV, Tb.N. and trabecular connectivity compared with the acellular dense collagen scaffold.

**Conclusion:** Bone fragility in elderly C57Bl6 mice led to post operative fracture after generation of a non-critical sized drill hole defect in the proximal femur whereas age-matched C3H mice with higher bone mass sustained no fractures. Dense collagen scaffolds supported the survival and osteoblast differentiation of bone marrow derived MSC in 3D culture. Their superior mechanical properties allowed for transplantation into non-critical sized femoral defects, suggesting the approach shows promise as adjunct therapy for use with bone grafts and implants in patients with poor quality bone.

10 - Anti-biofilm Activity of Subinhibitory Povidone-iodine Concentrations Against Staphylococcus Epidermidis and Staphylococcus Aureus
Kayode Olajide Oduwole, IE; Aaron A Glynn, IE; Funso O Onayemi, IE; Diamuirid Molony, IE; Jim P O Gara, IE; Damien McCormack, IE;
Purpose: Biomaterial-related infections continue to hamper the success of reconstructive and arthroplasty procedures in orthopaedic surgery. Staphylococci are the most common etiologic agents, with biofilm formation representing a major virulence factor. Environmental stress factors and sub-inhibitory concentration of some antibiotics have been identified to trigger staphylococcal biofilm formation through increased icaADBC expression. In staphylococci, production of polysaccharide intercellular adhesin (PIA) by the enzyme products of the icaADBC operon is the best understood mechanism of biofilm development, making the ica genes a potential target for biofilm inhibitors. Aims of the current study were 1. Determine the minimum inhibitory concentration (MIC) of Povidone-iodine. 2. Investigate the effect of Povidone-iodine on icaADBC operon encoded staphylococcal biofilm formation. 3. Investigate whether any observed changes on biofilm by Povidone-iodine is mediated through a change in icaADBC operon.

Method: MIC of povidone-iodine for both reference strains and strains isolated from infected orthopaedic implants was determined. Biofilm assay was performed at different Povidone-iodine concentrations using 96-well polystyrene plates. Total RNA for cDNA synthesis was isolated from bacteria at different twofold dilutions of Povidone-iodine concentrations. Real time polymerase chain reaction was used to quantify effects of Povidone-iodine on gene expression pattern of the icaADBC operon using the constitutively expressed gyrB gene as an internal control.

Results: The MIC of povidone-iodine was 1.4% for all bacterial strains. Clinical in-use doses of povidone-iodine prevented biofilm formation. A step-wise reduction of biofilm was observed at increasing sub-inhibitory doses of povidone-iodine (p<0.0001). IcaA expression correlated with biofilm formation in staphylococcal organisms. Decrease in icaA expression was strongly associated with an increase in expression in the biofilm repressor gene, icaR. The repressive effect of povidone-iodine on biofilm formation by Staphylococcal bacteria is by a separate mechanism from its bacteriostatic mechanism of action.

Conclusion: This study shows that icaR is a potential therapeutic target through which the ability of Staphylococcal bacterial to form biofilm may be reduced. These data reveal an additional therapeutic benefit of povidone-iodine and suggest that studies to evaluate the suitability of povidone-iodine as biomaterial coating agent to reduce device-related infection rates are merited.

Paper Session #2 COA/CORS Combined Arthroplasty

11 - The Effect of Tobramycin on Femoral Stem Migration: A Two-Year RSA Study
Thomas R Turgeon, MB; Eric Bohm, MB; Nathan Kesler, MB; Martin Petrak, MB; Colin Burnell, MB; David Hedden, MB;

Purpose: The purpose of this study is to determine if the addition of Tobramycin antibiotic powder to cement for primary hip replacement surgery increases the risk of long term aseptic loosening. This was accomplished by measurement of implant micromotion with Radiostereometric Analysis (RSA).

Method: Exeter femoral stems and Trident acetabular components were implanted into 33 patients. Stems were cemented in a randomized manner with either Simplex P or Simplex T. Tantalum beads were injected into the femur to serve as reference points for RSA measurements. RSA examinations were taken with supine positioning at six weeks, six months, one year, and two years post-operatively. Radiographic measurements and analyses were performed with the UmRSA software suite version 6.0 (RSA Biomedical, Umea, Sweden). Distal migration of the stem centroid was measured at each follow-up period and the mean migration rates for both groups were determined. Non-inferiority testing of stem migration in Simplex T compared to Simplex P was accomplished using a one sided t-test, with the significance level set at 0.05. A clinically inferior additional amount of distal migration was set at 0.4mm/yr.

Results: Eleven patients were excluded from the study: seven patients either dropped out of the study or missed the six week and/or two year follow-up examinations, two patients had radiographic image quality issues, and two patients had loosening of their tantalum markers in subsequent follow-ups. Of the remaining 22 patients, eight were male and 14 were female, with an average age at time of surgery of 71.2 (range, 63-81) years. The mean total distal migrations for the Tobramycin and non-Tobramycin cement groups at two years were 0.891 and 0.732 mm, respectively; the mean stem migration rates were 0.263 and 0.179 mm/yr, respectively. The differences in total distal migration and stem migration rate were not statistically significant (P = 0.06 and UCL = 0.173, respectively).

Conclusion: The addition of Tobramycin to Simplex cement does not appear to impact the distal migration pattern for a polished tapered cemented hip stem at two years. This finding suggests that Tobramycin does not have any clinically relevant deleterious effects on the in vivo mechanical properties of Simplex cement.

12 - A Comparison of Functional Outcomes Between Elective Coronary Artery Bypass Graft Surgery and Elective Lower Extremity Joint Replacement Surgery
Ili Slobodian, MB; Eric Bohm, MB; Jo-Anne V Sawatzky, MB; Carolyn De Coster, AB; Martin J Petrak, MB;

Purpose: Deciding how to allocate scarce surgical resources is a worldwide issue. These decisions can be especially difficult when considering procedures aimed primarily at improving functional quality of life, such as lower extremity joint replacement (LEJR) surgery, and those procedures that can be perceived primarily as life preserving but should also have an impact on physical function, such as coronary artery bypass graft (CABG) surgery. A comparison of the functional outcomes of these two different procedures may provide further evidence to guide resource allocation decisions. The purpose of this study is to compare patient-reported functional outcomes following CABG and LEJR surgery using standardized, validated outcome metrics.
Method: A retrospective review of prospectively collected pre and post-operative health related quality of life (SF-36) measures from patients undergoing elective CABG and elective LEJR surgery in an academic surgical center. The sample included 112 CABG patients who were matched with LEJR patients based on gender and age.

Results: The mean age in the CABG group was 63 years, in the LEJR group 64 years. Seventy eight percent (78%) of the patients were male. Pre-operatively, CABG patients reported statistically higher (p<0.05) Physical Functioning, less Bodily Pain, and superior Physical Component summary SF-36 scores compared to the LEJR group. However, their pre-operative General Health scores were statistically lower. Surgery resulted in a general improvement in all SF-36 scales and summary scores for all patients, with statistically significant improvements in Bodily Pain and General Health Scores occurring in both groups. Interestingly, the improvement in Bodily Pain score was greater for the LEJR group than the CABG group, whereas the improvement in General Health Score was greater in the CABG group. However the pre-operative pattern of statistically better Physical Functioning, Bodily Pain and Physical Component summary SF-36 scores in the CABG group, and superior General Health scores in the LEJR group remained following surgery.

Conclusion: It appears that, despite being matched for age and gender, significant pre-operative general health differences exist between CABG and LEJR patients that persist post-operatively. While surgery does result in significant improvements for both groups, CABG patients enjoy greater improvement in General Health scores while LEJR patients benefit from greater improvements in Bodily Pain scores. Further research is currently underway to examine how these differences are reflected in disease-specific scores and in health care resource utilization.

13 - Interface Distraction and Loosening of the Polyethylene Glenoid Implant for Various Joint Loading Modalities: Implications for Failure in Total Shoulder Arthroplasty

Joshua W Giles, ON; Andrew Glennie, ON; Louis M Ferreira, ON; George Athwal, ON; Kenneth J Faber, ON; James A Johnson, ON;

Purpose: Loosening of glenoid components in total shoulder arthroplasty is a common clinical problem which can necessitate revision surgery. The mechanism of loosening is poorly understood and may relate to implant design, component fixation techniques, and interfacial tensile stresses. We are unaware of any studies that have examined the fundamental aspects of load transfer to bone for various joint loading configurations. Hence, the objective of this study was to investigate the effect of joint loading on bone strain adjacent to a polyethylene glenoid implant.

Method: Five specimens (4 males; avg age: 59.5 yrs) implanted with a cemented, all polyethylene component (Anatomical Shoulder; Zimmer) were tested using an apparatus capable of producing loading vectors with various angles, magnitudes and directions. Each specimen was tested using a ramp load of 0-150 N (at 10N/sec) in two directions (superior and inferior) and with six angles of load application. A uniaxial strain gauge was placed in each of the four quadrants of the glenoid, approximately 1 mm medial to the glenoid rim. The primary axis of each strain gauge was oriented medio-laterally to record bone strains. The humeral head was simulated by a custom steel ball with a radius of curvature consistent with a nonconforming humeral prosthesis.

Results: The relationship between strain and applied force was not linear (superior quadrant at 40°: linear fit R²=0.96; quadratic fit R²=0.999; p<0.0005), and was dependent on the loading angle. During pure compressive loading, tension was observed in the superior and inferior quadrants of the glenoid; while less consistent results in the anterior and posterior quadrants revealed variable tension and compression. Superior and inferior loading each caused increasing ipsilateral tension, occurring from 0-30° and 0-20°, respectively.

Conclusion: The current study is thought to be the first to directly measure load transfer at the implant-bone interface. We demonstrated load transfer nonlinearities between a surgically implanted glenoid component and the underlying bone in all locations and for a wide range of loading conditions. This has important implications towards the modeling of these constructs using finite element analyses. The results also illustrate tensile loading during compressive and small eccentricity loading cases. These results suggest a polyethylene flexure, causing the periphery of the glenoid implant to flex upwards placing the cement mantle and underlying bone in tension. Tensile loads that are linked to cement mantle fracture and implant loosening are produced under loading conditions associated with activities of daily living. This study has provided insight into the mechanisms of load transfer between a cemented polyethylene glenoid implant and the underlying bone. Reduction or elimination of these interfacial tensile stresses around the glenoid periphery should be considered when developing novel methods for component fixation.

14 - Mechanical Stimuli Distributions in the Hip Joint Due to Cam Impingement and its Relation with the Progression of Osteoarthritis

Kwan-Ching Geoffrey Ng, ON; Gholamreza Rouhi, ON; Mario Lamontagne, ON; Paul E Beaulé, ON;

Purpose: Femoroacetabular impingement (FAI) is recognized as a pathomechanical process that leads to hip osteoarthritis (OA). Past research has been focused on treatments for FAI; however, few studies have been done to link FAI with the progression of OA. It is hypothesized that elevated mechanical stimuli could provoke bone remodeling in the subchondral bone and articulating surfaces due to cam FAI (aspherical head-neck deformity), which would accelerate the progression of OA. Using finite element analysis (FEA), the aim is to compare healthy hips to hips with cam FAI – investigating the mechanical stimuli effect of FAI towards OA.

Method: Net joint reaction forces were obtained from joint kinematics, kinetics, and by inverse dynamics calculation for a dynamic squat motion of a control subject and a cam FAI patient (both males with comparable age, BMI, and femur lengths). CT scans were acquired from both subjects. Data slices were compiled using 3D-DOCTOR (Able Software Corp, MA) to form a 3D model with slice thickness calibrated at 1.25mm in the superior-inferior axis. ANSYS (ANSYS, PA) software was used for FEA. The femur models were given quadrilateral shell elements and modeled as linear elastic orthotropic materials. The ground reaction forces were applied to the
femur models, simulating dynamic loads, using boundary conditions specific to hip loading. Von Mises stresses were determined to examine stress concentrations and adverse loading conditions. Strain energy distributions were determined to examine the effect of stimuli on the initiation and rate of bone remodeling.

**Results:** At the maximum squat-depth, the FEA results demonstrated that the net forces acting on the FAI hip produced high mechanical stimuli regions around the head and neck. The highest stress concentration (590 MPa) was located at the anterosuperior head-neck junction, where cam FAI is most prominent. For the control hip, stresses were significantly lower (maximum of 151 MPa) and dissipated around the head. For both the FAI and the control hip, the maximum strain energy concentrations were seen at the superior portion of the head (4.725 kJ vs. 2.192 kJ for FAI vs. control hip respectively).

**Conclusion:** The increase in mechanical stimuli can be due to the loading configurations as well as to the abnormal geometry of the cam deformity. Assuming that the strain energy density (SED) and its rate is linearly proportional to the rate of bone turnover, based on a recent semi-mechanistic bone remodeling theory, a higher rate of bone turnover is expected in the FAI than in a normal hip. Depending on the level and rate of SED, the rate of bone remodeling will vary in order to provide a new homeostatic configuration. The next-step analysis, examining the mechanical stimuli in the acetabulum and its cartilage, is currently in progress. This would provide useful information about the possible locations of OA initiation and establish a link between FAI with cartilage degeneration.

15 - Femoral Head Penetration in X3 Cross-linked Acetabular Liners: A Two-Year RSA Study

**Thomas R Turgeon, MB; Eric Bohm, MB; Nathan Kesler, MB; Martin Petrak, MB; Colin Burnell, MB; David Hedden, MB;**

**Purpose:** The purpose of this study is to measure in vivo linear head penetration of a newer generation highly crosslinked liner (X3, Stryker Orthopedics) using Radiostereometric Analysis (RSA).

**Method:** The 12 hips (11 patients) included in this study are a subset from a larger randomized controlled trial comparing Exeter stem migration in cement mantles with and without Tobramycin. Criteria for inclusion in this subset were the use of an uncemented Trident acetabular component containing X3 polyethylene in combination with a 32 mm stainless steel femoral head. The average age was 72.7 years (range 65 to 80), and there was an equal gender distribution. RSA examinations were taken with patients lying supine at six weeks, six months, one year, and two years post-operatively. The six week examinations were used as the reference examinations for measuring head penetration. Radiographic measurements and analyses were performed with the UmRSA software suite version 6.0 (RSA Biomedical, Umea, Sweden). Head penetration was determined via edge-detection measurements of the femoral head and acetabular cup.

**Results:** The mean cumulative femoral head penetration at 6 months was 0.23 mm; this remained statistically unchanged both at 1 year: 0.20mm (p=0.69, 95% UCL of the difference: +0.15mm) and 2 years: 0.25mm (p=0.77, 95% UCL of the difference: +0.10mm).

**Conclusion:** It is generally recognized that femoral head penetration of more than 0.1 mm per year can result in osteolysis. The purpose of cross linking polyethylene is to reduce wear to below this level. The results of this study show that after an initial bedding in of approximately 0.2 mm, femoral head penetration is not detectable over the subsequent 18 months. Further follow-up is underway to confirm that this promising reduction in wear is maintained.

16 - Predicting Functional Outcome of Femoral Neck Fractures Treated with Hemiarthroplasty

**G. Yves Laflamme, QC; Mathieu Carrier, QC; Louis Roy*, QC; Paul Kim, ON; Stephane Leduc, QC;**

**Purpose:** To determine if early functional assessment correlates and/or predicts long term function after hemiarthroplasty for displaced femoral neck fractures.

**Method:** We evaluated prospectively fifty six (56) patients with Garden-type III and IV femoral neck fractures in a Level 1 trauma center with a minimum of two years follow-up. Validated functional measures including Lower Extremity Measure (LEM) and Timed Up and Go (TUG) were used. Score progression was recorded and analyzed in relation to patient baseline data.

**Results:** The regression analysis between TUG times at three months and the mean LEM scores at two years follow showed a good correlation (R2=0.659). Further analysis determined that patients with TUG times of less than twenty (20) seconds at six weeks of follow-up had a mean LEM score significantly higher at both one year (81.5 vs 56.2; p<0.001) and two years follow-up (77.1 vs 41.8; p<0.001). This difference between mean LEM scores was also noted for the TUG values at three months.

**Conclusion:** The TUG test is an early clinical indicator of future function. Innovative clinical approaches such as the one demonstrated in this study to anticipate future function will contribute to increasing efficiency in the overall management of this growing patient population.

17 - Acetabular Component Migration Analysis of a Metal-on-Metal Hip Resurfacing

**Craig White, UK; Jamie Lopez Castellaro, ON; Paul E Beaulé, ON; Paul Kim, ON;**

**Purpose:** Although femoral neck fractures remain a concern in terms of short term failures for hip resurfacing, acetabular component position and fixation are increasingly being recognized as causes of mid term failures for hip resurfacing. The purpose of our study was to evaluate the migration pattern of a cementless acetabular component for a metal on metal hip resurfacing.

**Method:** Between January 2006 and June 2007, 130 patients underwent metal on metal hip resurfacing; 66 hips in 60 patients were included in this analysis. Forty-eight patients were male and 12 were female, with a mean age of 50 (range, 32-66). Ninety-five percent of the surgeries were performed for osteoarthritis. All surgeries were performed by two surgeons using the Conserve Plus (Wright Medical Technology, Memphis, TN) hip resurfacing system. The acetabular component is a monoblock cobalt chrome with a porous
beaded surface for osteointegration. In all cases acetabular migration was measured both vertically and horizontally, on serial radiographs using the computer-assisted Ein Bild Röntgen Analyse (EBRA) method. A minimum of three comparable radiographs is necessary for calculating the migration curves. We scored medial migration as negative horizontal movement.

Results: At a mean follow up 25.3 months (range, 24-36 months), each hip had an average of 5.1 radiographs for analysis. The software excluded two cases for poor comparability ending finally with 64 cases for the analysis. Eighty-seven point five per cent of the cases showed less than 1 mm migration in the medio-lateral axis and 54.7% less than 1 mm in the vertical axis. Seventy-seven percent of the cases showed a combined migration of less than 2 mm in the observation period, without radiolucencies, leaving 23% of the acetabular components with 2 mm or greater of component migration. One of these cases required revision for aseptic loosening at 34 months.

Conclusion: In our study the majority of the acetabular components were stable with some of the migration observed secondary to lack of complete initial seating due to the rigidity of the shell. Krismer et al did report on the migration of the PCA shell (also a porous beaded cobalt-chrome shell) using EBRA, with 27.5% of the shells demonstrating >1 mm of migration. Although hip resurfacing has only mid term followup, results have been good to excellent. Caution should still be maintained since the higher frictional torque generated by the larger femoral head size as well as the nanometer size particles could negatively affect long term fixation of the acetabular component.

18 - Metal Ion Release: Comparison of Four Large Diameter Metal-on-Metal Bearing Articulations
Sanket Diwanji, QC; Martin Lavigne, QC; Étienne Belzile, QC; François Morin, QC; Alain Roy, QC; Pascal-André Vendittoli, QC;

Purpose: Tribological studies of hip arthroplasty suggest that larger diameter metal-on-metal (MOM) articulations would produce less wear than smaller diameter articulations. Other advantages of these large femoral head implants include better stability with lower dislocation rates and improved range of motion. The aim of the present study was to compare chromium (Cr), cobalt (Co) and titanium (Ti) ion concentrations up to one year after different large diameter MOM total hip arthroplasties (THAs).

Method: One hundred and twelve patients were randomized to receive large (femoral head >36 mm diameter) metal-on-metal articulation THA (LDH) from one of the following companies: Zimmer, Smith & Nephew, Biomet or Depuy. Samples of whole blood were collected pre-operatively and post-operatively at six months and one year. Cr, Co and Ti concentrations were measured by high-resolution mass spectrometry in an independent laboratory. All LDH implants have a modular Cr-Co tapered sleeve for leg length adjustment, except for Biomet with its sleeve made of Ti. All groups had Ti stems, and Zimmer and Biomet had, in addition, a Ti acetalobular porous surface for secondary fixation. We undertook statistical analysis (SPSS 14.0) with p<0.05 as significant.

Results: The groups were comparable in respect to pre-operative parameters (age, gender ratio, body mass index, etc.) as well as post-operative functional scores at six months and one year. We found that Biomet, Depuy and Smith & Nephew LDH had similar Co ion levels at 12 months post-op with 1.5, 1.4 and 1.6 ug/L, respectively. Durom LDH had the highest Co level with 2.3 ug/L (p<0.01 versus the three other groups). The highest Ti ion levels were observed in the Zimmer group with 3.2 ug/L (p<0.01 versus the three other groups) and the Biomet group with 2.0 ug/L (p=0.01 versus Zimmer and NS versus the other 2). Ti levels tripled versus pre-op for BHR and ASR (0.5 versus 1.5 and 0.5 versus 1.4 ug/L).

Conclusion: Different implant factors may influence metal ion levels measured in whole blood: articular surface wear and implant passive corrosion. Zimmer’s Durom LDH presents higher Co levels than the other groups. Since previously-published Durom hip resurfacing (same bearing characteristics as Durom LDH) showed much lower Co ion results, the modular sleeve may be incriminated. The plasma-sprayed acetabular surface of Zimmer’s and Biomet’s components seems to be responsible for the significant difference in Ti versus the other implants. Biomet’s plasma-sprayed Ti appears to be less prone to corrosion than Durom’s plasma spray coating. When evaluating metal ion release from MOM THA, total metal load from the implants should be considered, and newer implant designs should be evaluated scientifically before their widespread clinical use. LDH-THA should be seen as an improvement and should not be blamed as the source of metal ion release when a specific implant produces unsatisfactory results.

19 - One-year Results of an RCT using RSA to Compare Minimally Invasive Surgery (MIS) to Standard Exposure in Primary Uncemented Modular THA
Michael Gross, NS; David Amirault, NS; Allan Hennigar, NS; Michael J Dunbar, NS

Purpose: To determine if MIS for primary hip replacement surgery increases the risk of long term aseptic loosening as predicted by implant micromotion measured with radiostereometric analysis (RSA).

Method: Ninety patients undergoing primary THA for osteoarthritis (exclusion criteria: post-traumatic arthritis, rheumatoid arthritis, hip dysplasia, previous hip infection) were randomized to undergo THR surgery utilizing the standard direct lateral approach (n=45; 24 male; age=58 yrs; BMI=27) or MIS via a one-incision direct lateral approach using specific instrumentation (n=45; 23 male; age=55; BMI=29). Uncemented acetabular and femoral (ProfemurZ) components were used with ceramic on ceramic bearings. The femur was marked with 9 tantalum beads placed in the greater trochanter, lesser trochanter, and femoral shaft distal to the tip of the prosthesis. Post-operative care was be standardized according to the care maps at our institution. Primary outcome measure was femoral stem MTTPM (maximum total point motion) measured using Model-based RSA. Stereo supine X-rays were taken before weight bearing and 3, 6, and 12 months postoperatively. At the same time intervals Harris Hip Score, Oxford-12, WOMAC, and SF36 questionnaires were administered. Rates of infection, dislocation and revision were recorded.

Results: Eleven patients were lost to follow-up (4 due to missing post-op exams; 5 did not have enough beads placed during surgery; 2 were revised due to failure of the ceramic femoral head). There were five long neck fractures at 17-30 months postop that are reported
in detail in a related abstract. There were no differences between groups for all outcome measures. Mean MTPM at 12 months was 2.5mm (SD=1.8mm) for the MIS group and 2.6mm (SD=1.2mm) for the standard group.

**Conclusion:** No difference between groups at one year indicates MIS for uncemented primary THR through a direct lateral approach does not appear to negatively affect stability of the femoral stem. Although promising, these results require confirmation with 2-year RSA data.

**20 - The Effect of THA Surgical Approaches on Lower-limb Joint Mechanics During Stair Ascent**

Daniel Varin, ON; Mario Lamontagne, ON; Melanie Beaulieu, ON; Paul E Beaulé, ON;

**Purpose:** It is thought that the anterior approach better restores gait mechanics after total hip arthroplasty (THA) being a pure intermuscular/internervous approach. The purpose of this study was to compare three-dimensional (3-D) kinematics and kinetics of THA patients that had an anterior (ANT) vs. a lateral (LAT) approach. It is hypothesized that the ANT group will exhibit fewer differences than the LAT group when compared to a control group (CON).

**Method:** Fifty-four participants were divided into three groups of 18: ANT (12 women, 6 men; age: 60.9 ± 6.2 yr; BMI: 28.8 ± 4.9 kg/m2), LAT (10 women, 8 men; age: 65.2 ± 6.3 yr; BMI: 27.5 ± 5.1 kg/m2) and CON (9 women, 9 men; age: 63.9 ± 4.4 yr; BMI: 25.4 ± 3.2 kg/m2). All THA patients had primary unilateral THA due to osteoarthritis and had no other lower-limb pathology. They were evaluated five to 17 months after surgery. 3-D kinematics and kinetics were obtained using a nine-camera motion analysis system and a force platform placed on the first step of a staircase. Each participant performed three trials of stair ascending. A series of one-way ANOVAs were used to compare peak angles, range of motion (ROM), peak resultant joint forces as well as moments and powers of the hip, knee and ankle joints in all three planes.

**Results:** Most differences occurred during transitions between double- to single-legged stance. Both LAT and ANT groups ascended the staircase with a more abducted hip than the CON group, resulting in reduced hip abduction moment. This could be the result of the implant’s position and its potential abductor lever arm reduction. Both groups also showed reduced peak internal rotation moments. These results have previously been found in THA patients who have been operated through lateral and posterior approaches, and are thought to be caused by hip abductor muscle damage inherent to the surgical approach. However, only the LAT group had lower compression forces at the hip, knee and ankle joints compared to the CON group. This indicates that LAT group uses a strategy that reduces the loading on the operated leg, which may be due to the detachment of the anterior third of the gluteus medius. It could be speculated that the muscle sparing aspect of ANT approach allows patients to load adequately their operated leg, even if their frontal plane kinematics and kinetics are altered.

**Conclusion:** Some studies have failed to find differences with the anterior approach. However, they have only looked at spatiotemporal gait parameters. 3-D kinematics and kinetics can provide a more detailed assessment of function and detect more subtle differences. In this study, 3-D biomechanical analysis has detected differences in THA patients operated through different surgical approaches during stair ascent. The data obtained showed similar frontal plane kinematics for both groups, but different lower-limb compression forces. This study supports the use of the anterior approach for better restoration of function after total hip arthroplasty.

**Paper Session #3 CORS Extremities**

**21 - Human Male Elbow Joint Capsule Molecular Profiles in Primary Osteoarthritis and Post-traumatic Contractures**

Kevin A Hildebrand, AB; David A Hart, AB;

**Purpose:** Elbow osteoarthritis (OA) is characterized by a loss of elbow motion secondary to joint capsular hypertrophy and osteophyte formation. Previous work on joint capsules in post-traumatic (PT) elbow joint contractures has shown that alterations in cell populations (increased number of alpha-SMA positive myofibroblasts), matrix molecule and enzyme, and growth factor mRNA profiles are associated with loss of elbow motion in this condition. The objective of this study was to determine whether alterations in joint capsule parameters were similar or different in two etiologies of human elbow contractures, primary OA and PT.

**Method:** Posterior elbow joint capsules were obtained from eight male patients with primary elbow OA (age 52±12 yr), five male patients with chronic (> 1 year) PT (age 47±12 yr) and four male organ donors free of OA and contractures (age 43±10 yr). mRNA was extracted for subsequent real-time PCR for alpha-SMA, interleukin-1beta, MMP-1, MMP-3, collagen type III, biglycan, versican, tenascin C, TIMP-1, MMP-2, iNOS, COX-2, glyceraldehyde -3 phosphate dehydrogenase (GAPDH) and 18S. 18S was used to normalize gene expression. Statistical comparisons used a one-way ANOVA followed by posthoc Tukey test. Significance was p < 0.05.

**Results:** The mRNA levels in the OA and PT capsules were increased compared to controls in most cases. This includes the major matrix molecule collagen I and the myofibroblast marker alpha-SMA, the growth factors TGF-beta1 and CTGF plus decorin, the injury response elements (collagen III, biglycan, versican, tenascin C) as well as TIMP-1 and MMP-2. The housekeeping gene GAPDH was similar in all 3 groups as was COX-2, while iNOS was elevated in both groups characterized by contractures. When comparing the two contracture groups, the mRNA levels were similar for some molecules while differences were evident in other instances. In PT, alpha-SMA and collagen I were greater than in OA. Conversely, in the OA group, the growth factors and matrix enzyme systems exhibited higher levels than PT.

**Conclusion:** In this study of human elbow joint capsules, we have shown that relative mRNA levels for markers of myofibroblasts, major matrix components, injury response elements and selected growth factors are significantly elevated in elbow OA and post-
traumatic contractures when compared to age matched organ donor controls free of contractures. When comparing the OA and PT groups, the injury response molecules were elevated to similar relative levels. The OA group had greater increases in the growth factors and many of the matrix enzymes / inhibitors measured, while the PT group had greater increases in the myofibroblast marker alpha-SMA and the major matrix molecule collagen I. Thus in general matrix, growth factor and cellular properties appear to be preferentially altered in the two conditions studied when compared to control tissues, strengthened by the fact that the housekeeping gene GAPDH had similar relative levels in all 3 groups.

22 - Determination of the Centre of the Capitellum for Elbow Reconstructive Procedures: The Effect of Digitization Protocols
Jennifer Ng, ON; Emily A Lalone, ON; Colin P McDonald, ON; Louis M Ferreira, ON; Graham J King, ON; James A Johnson, ON;

**Purpose:** The identification of anatomical landmarks is an important aspect of joint surgery, to ensure proper placement and alignment for implants and other reconstructive procedures. At the elbow, the center of the capitellum (derived via a digitization of the surface and subsequent sphere fitting) has been well established as a key landmark to identify the axis of rotation of the joint. For some cases, and in particular minimally invasive surgery, only small regions of the capitellum may be exposed which may lead to errors in determining the centre. The purpose of this study was to identify the optimal location of digitizations of the capitellum.

**Method:** Twenty-five fresh frozen cadaveric distal humeri (19 left, 6 right) were studied. Using an x-ray computed tomography scanner, volumetric images of each specimen were acquired and used to reconstruct a 3-dimensional digital model of the specimen using the Visualization Toolkit (VTK). A sphere-fit algorithm was used to determine the centre of the spherical capitellum based on manually chosen (digitized) points across the 3D capitellar surface. The true geometric centre was located by digitizing points across the entire capitellar surface. Three sub-regions of the capitellum, commensurate with typical surgical approaches with minimal dissection, were then digitized. These were superior anterior lateral (SAL), inferior anterior lateral (IAL) and a combination of these two regions. These regions were compared to the true centre using a 1-way Repeated Measures ANOVA with significance set to p = 0.05.

**Results:** Digitizations of only SAL and IAL sub-regions resulted in the largest differences relative to the true centre: SAL = 3.9±3.4 mm, IAL = 4.2±3.4 mm, (p < 0.0005). There was no difference between SAL and IAL (p = 1.0). Digitization of the combined SAL + IAL regions, while significantly different from the entire capitellum, resulted in the smallest mean difference of 0.87±0.84 mm.

**Conclusion:** These data show that the region of digitization affects the accuracy of predicting the capitellum centre. In a previous study by our group, we showed that an accurate determination of the centre of a sphere can be achieved with a small surface area of digitization. In the current study, the large errors that occurred when a small surface was digitized (i.e. SAL and IAL alone), are in all likelihood, due the non-spherical nature of the capitellum. In summary, while the most precise method in locating the true centre is to digitize the entire capitellar surface where possible, an alternative approach is to digitize both the superior and inferior anterior lateral regions.

23 - Predictive Anthropometric Measurements for Humeral Head Curvature
Anthony Miniaci, US; Stephen D Fening, US

**Purpose:** Osteochondral allograft transplantation for the treatment of osseous defects to the humeral head has recently grown in popularity. Because only a portion of the articulating surface of the humeral head is replaced, conformity of the allograft to the native surface is imperative to restore the natural geometry of the joint. To achieve proper conformity, it is essential that the curvature of the humeral head of the allograft tissue match that of the native tissue. Curvature determination is also important for shoulder replacement procedures. Curvature of the humeral head is difficult to directly measure in allograft specimens. As a result, predictive measurements, such as the maximum length of the humerus are used to predict this curvature. The purpose of this study was to investigate the value of various anthropometric measurements for predicting humeral head curvature. We hypothesized that the maximum length of the humerus would be the most predictive of humeral curvature.

**Method:** 60 (28 female, 32 male) cadaveric humeri were obtained from the Hamann-Todd Human Osteological Collection. Specimens ranged from 20 to 35 years of age at the time of death (27.9 ± 4.5, mean ± SD). Specimens from this collection include height and weight as collected at the time of death. All specimens were scanned with a 3-dimensional laser scanner (NextEngine, Santa Monica, California, USA). This scanner has been shown to be accurate to within 0.005 inches. Linear measurements (maximum humeral length, epicondylar breadth) were made according to the recording standards for skeletal remains. Both measurements were made by choosing points on the 3-dimensional scan, rather than the traditional osteometric board. Humeral head curvature was determined by a custom computational code to fit a sphere to the articulating surface of the humerus. Data analysis was performed in Minitab (version 13, State College, PA, USA). A linear regression was performed for each predictive measurement. A stepwise linear regression with forward and backward substitution was performed for the most predictive variables from the initial linear regression.

**Results:** The most predictive factors (R^2 > 0.5) were epicondylar breadth, height, maximum humeral length, and gender. Based on the linear regression coefficients, these four factors (all normalized) were included in a forward and backward stepwise regression (alpha to enter and remove = 0.15). The resulting equation (shown below) had an R^2 values of 0.807. Humeral Diameter = 0.894 + 0.048*(epicondylar breadth) + 0.043*height – 0.020*gender

**Conclusion:** Of the predicted measurements evaluated, patient height, epicondylar breadth, and gender were most correlated with humeral head curvature. Including these three factors in a linear regression model increased the R2 value to 0.807. If only a single measurement can be used to size the humeral curvature, patient height will give approximately the same accuracy as epicondylar breadth, and can more easily be obtained.
24 - Distal Ulnar Load with Simulated Colles Fractures
Graham JW King, ON; Gillian S Greeley, ON; Brendon JB Beaton, ON; Louis M Ferreira, ON; James A Johnson, ON;

**Purpose:** This in-vitro study examined the effect of simulated Colles’ fractures on load transmitted to the distal ulna, using an in-line load cell. Our hypothesis was distal radial fracture malposition will increase distal radial ulnar joint (DRUJ) load relative to the native position of the radius.

**Method:** Eight fresh frozen upper-extremities were mounted in a motion simulator which enabled active forearm rotation. An osteotomy was performed just proximal to the distal radioulnar joint, and a 3-degree of freedom modular appliance was implanted which simulated Colles type distal radial fracture deformities. This device allowed for accurate adjustment of dorsal angulation and translation (0, 10, 20 and 30 degrees dorsal angulation and 0, 5 and 10mm dorsal translation both isolated and in combination). A 6-DOF load cell was inserted in the distal ulna 1.5 cm proximal to the ulnar head to quantify DRUJ joint forces. Distal ulnar loading was measured following simulated distal radial deformities with both an intact and sectioned triangular fibrocartilage complex (TFCC).

**Results:** The maximum resultant transverse distal ulnar load occurred during active forearm pronation and supination. Increasing magnitudes of dorsal angulation and translation of the distal radius increased loading in the distal ulna. For pronation with the ligaments intact, the transverse resultant load for the non-fracture, native positioning was significantly lower (p<0.05) than the majority of malpositioned cases except for the translations only (not combined with angulation). However, all fracture orientations for supination had an increased effect on the resultant loading (p<0.05) when ligaments were intact. Greater forces were measured in the distal ulna when the TFCC intact relative to TFCC sectioning. Sectioning the TFCC eliminated the effect of fracture malposition for both pronation and supination. The range of maximum transverse force for intact pronation and supination was between 118±34N and 130±39N, respectively. Similarly, for sectioned pronation and supination, the maximum transverse forces were and 93±40N and 89±24N, respectively.

**Conclusion:** Malpositioning of distal radial fractures in dorsal translation and angulation was found to increase forces in the distal ulna, which may be an important source of residual pain following malunion of Colles’ fractures. Healing of the distal radius in an anatomic position resulted in the least forces. Sectioning the TFCC released the tethering effect of the radius on the ulna, decreasing DRUJ force. This is the first study of its kind to attempt to quantify the forces at the DRUJ as a result of Colles’ fractures, and these early findings provide important baseline information related to the biomechanics of the DRUJ.

25 - Computer-generated Instrument Guides for Distal Radius Osteotomy: A Preliminary Clinical Trial
David Pichora, ON; Manuela Kunz, ON; Burton Ma, ON; John F Rudan, ON; Randy E Ellis, ON; Hisham Alsanawi, ON;

**Purpose:** The purpose of this clinical trial was to investigate the accuracy of a novel method for computer-assisted distal radius osteotomy, in which computer-generated patient-specific plastic guides were used for intra-operative guidance. Our hypothesis was that these guides combine the accuracy and precision of computer-assisted techniques with the ease of use of mechanical guides.

**Method:** In a consecutive series of 9 patients we tested the accuracy of the proposed method. Prior to surgery, CT scans were obtained of both radii and ulnae in neutral rotation. Three-dimensional virtual models for both the affected and unaffected radius and ulna were created. The models of the unaffected radius and ulna were reflected to serve as a template for the correction. Custom-made software was used to plan the correction. The locations of the distal and proximal drill holes for the plate were saved and the locations of the distal holes before the osteotomy were determined. The design of a patient-specific instrument guide was calculated, into which a mirror image of intra-operative accessible bone structure of the distal radius was integrated. This allowed for unique positioning of the guide intra-operatively. For each planned drill location a guidance hole was incorporated into the guide. A plastic model of the guide was created using a rapid prototyping machine. Intra-operatively, a conventional incision was made and the guide was positioned on the distal end of the radius. The surgeon drilled the holes for the plate screws into the intact radius. The guide was removed and the surgeon performed the osteotomy using the conventional technique and shaved the bone from the distal radius fragment to accommodate the plate. Using the pre-drilled holes the plate was affixed to the distal radius fragment. The distal fragment was reduced until the proximal screw holes in the plate aligned with the pilot holes in the bone. To analyze the accuracy of the intra-operative procedure we compared the post-operative alignment of the radius with the planned alignment. A lateral and an A/P digitally reconstructed radiograph (DRR) of the plan were calculated. These DRRs were used to evaluate the radial inclination, the volar tilt and the ulnar variance of the planned alignment. Post-operative lateral and A/P X-Rays were used to determine the same three post-operative radiographic indices. The post-operative values were compared with the planned values.

**Results:** We found an average deviation for the radial inclination of 0.5°(StDev 1.8), for the volar tilt of 0.7°(StDev 2.3), and for the ulnar variance of 0.8mm (StDev 1.9).

**Conclusion:** These results show that the computer-generated instrument guides accurately achieved the planned alignment. The guides were easy to integrate into the surgical workflow and eliminated the need for intra-operative fluoroscopy for guidance of the procedure.

26 - Visualization of 3D Elbow Kinematics Using Reconstructed Surfaces
Emily A Lalone, ON; Colin P McDonald, ON; Louis M Ferreira, ON; Graham King, ON; James Johnson, ON;

**Purpose:** Current techniques for the investigation of elbow stability following injury or surgical interventions rely on kinematic descriptors. Typically, the motion pathways of the bones are employed to describe the effect of various clinical variables on alignment joint stability. This study describes a new approach to better visualize joint motion pathways that relates the anatomical geometry of the
joint, obtained using medical imaging, with the recorded motion of the joint. The clinical aim of our study was to use this approach to investigate the effect of radial head resection and subsequent radial head arthroplasty on joint kinematics and elbow stability.

**Method:** Five fresh-frozen cadaveric specimens were employed. Computed tomography (CT) scans of each upper extremity were obtained to create a three-dimensional model of the joint. Simulated active elbow flexion with the arm in the valgus gravity loaded position was achieved using an upper arm simulator previously developed in our laboratory. Receivers from an electromagnetic tracking device were attached to the humerus and ulna in order to record their relative motion. Sutures were secured to the tendons of relevant muscles, which were connected to servomotors and pneumatic actuators, used to simulate motion. Kinematic data was collected with the radial head intact, radial head resected and following placement of metallic radial head implant. A repeated-measures analysis of variance was used to detect statistical differences. After testing, each specimen was denuded of all soft tissue and disarticulated. Fiducial markers were attached to the humerus and the ulna. The joint was then re-imaged in the CT scanner to obtain a volumetric image of each fiducial. Using the kinematic data recorded during simulated motion, and the knowledge of the position of each fiducial, a direct visualization of the recorded motion, using the 3D models was obtained. The bony position was then compared to the traditional graphical kinematic analysis examining changes in valgus angulations throughout the arc of motion.

**Results:** We observed a close agreement between the kinematic output and the registered bony 3D models showing the joint position. Following resection of the radial head, in the valgus dependent position, there was an increase in the valgus angulation of the ulna with respect to the humerus ($p<0.05$).

**Conclusion:** Using this visualization approach, these changes in bony alignment were readily observed and understood visually in the 3D model of the ulna. Unlike the traditional graphical approach used to investigate elbow stability, this technique allows for the representation of coupled motion (rotation) of the bones. This technique also permits direct visualization the relative position of the bones within the joint, hence improving the overall understanding of joint motion.

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**27 - Tourniquet-induced Skeletal Muscle Oxidative Injury during Lower Limb Orthopaedic Trauma Surgery**

**Luke W Harris, BC; Babak Shadgan, BC; Darlene Reid, BC; Scott K Powers*, US; Peter J O’Brien, BC;**

**Purpose:** It is well established that skeletal muscle ischemia followed by reperfusion induces oxidative damage, metabolic stress, and an inflammatory response. This ischemia-reperfusion injury has been studied extensively in experimental models and, importantly, in the clinical setting where it is associated with tourniquet (TQ) inflation during orthopedic trauma surgery. Of particular clinical concern is the notion that reperfusion upon TQ release is central to oxidative injury, since release necessarily follows surgery. Consequently, the effects of ischemia alone, without reperfusion, is poorly documented. That is, it remains unknown what are the effects of muscle ischemia, per se, on muscle properties that could influence functional recovery postoperatively or what preventative measures might be taken to minimize the potentially deleterious effects of the ischemic period alone. Hence the purpose of this study was to investigate changes in myofibrillar contractile protein oxidation over the course of TQ-induced leg muscle ischemia during orthopedic trauma surgery.

**Method:** Among patients with unilateral ankle fractures requiring surgery at our institution, 24 subjects gave informed consent to participate. All subjects underwent standard general anesthesia. PRE surgical biopsies were collected from the peroneus tertius muscle (PT) immediately after TQ inflation and incision of the skin and underlying connective tissue. POST surgical biopsies were collected from the same muscle immediately before TQ release. Oxidation of PT myosin, actin, and total protein was quantified using Western blot analysis for 4-hydroxynonenal (4-HNE) modified proteins. Results are reported as mean ± standard deviation.

**Results:** Total TQ time ranged from about 21 to 84 min (50.5±16). As anticipated, in PRE biopsies compared to POST biopsies there were large increases in the PT content of 4-NE modified myosin (174.4±128%; $P<1\times10^{-5}$), actin (223.7±182%; $P<5\times10^{-9}$), and total protein (567.5±378%; $P<5\times10^{-7}$). Intriguingly, there was a much greater increase in PT protein oxidation in males than in females (43.3% difference; $P<0.05$), although there was no relationship observed between PT protein oxidation and subject age. Surprisingly, there was no significant relationship between muscle protein oxidation and duration of the TQ-induced ischemia.

**Conclusion:** TQ-induced skeletal muscle ischemia for 21 to 84 min during orthopedic trauma surgery leads to considerable oxidative muscle injury as measured by muscle protein oxidation, including of the functionally relevant contractile proteins myosin and actin. This injury occurs even without reperfusion. Interestingly, the extent of oxidative muscle injury appears to be influenced by gender, but is not dependent upon the duration of ischemia. **FUNDING:** MSFHR, COF, BCLA.

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**28 - Leg Muscle Oxygenation and Hemodynamics during Tourniquet-induced Ischemia Monitored by Near-infrared Spectroscopy**

**Babak Shadgan, BC; Darlene Reid, BC; Peter J O’Brien, BC;**

**Purpose:** Near-infrared spectroscopy (NIRS) detects changes in chromophore concentrations of oxygenated (O2Hb) and deoxygenated hemoglobin (HHb) in target tissues approximately 2 to 3 cm below the skin. The main purpose of this study was to non-invasively measure skeletal muscle oxygenation in the leg during and after tourniquet (TQ)-induced ischemia using continuous wave NIRS. Secondly, we aimed to assess the sensitivity, specificity, and reliability of this optical technique for detection and continuous monitoring of changes in muscle oxygenation and hemodynamics during TQ-induced ischemia throughout orthopedic surgery.

**Method:** Consented patients aged 19-69 (n=21) with unilateral ankle fracture requiring emergency or elective surgery at our institution were recruited. All patients underwent standard general anesthetic. A pair of NIRS probes was fixed over the midpoint of the tibialis anterior muscle (TA) of both the fractured and healthy legs. A thigh TQ was applied to the injured leg and inflated to 300 mmHg. Using the NIRS apparatus coupled to a laptop with data acquisition software, changes in O2Hb, HHb, and total hemoglobin (tHb) levels in the...
TAs of both legs were measured at 10 Hz before and during TQ inflation, and after release until values returned to baseline. In each surgery the TQ was released when arterial obstruction was no longer required by the clinical team. Data are reported as mean±SD.

**Results:** Changes in O2Hb, HbHb, and thb were successfully collected, stored and transmitted for graphic display in all subjects. TQ time (ischemia interval) varied among subjects, from 1245 s to 4431 s (2753±854). NIRS measured a progressive increase in HbHb (2.6±2 µmol/L) during the first minute of TQ inflation and a sharp increase in O2Hb (23.3±12 µmol/L) during the first minute of leg muscle reperfusion (after deflation). Following TQ inflation a progressive increase in HbHb (24.2±10.3 µmol/L) with a concomitant decrease in O2Hb (mean -24.4±8 µmol/L) in the under-TQ TA were consistent across subjects. These changes in ΔHbHb and ΔO2Hb began to reverse immediately after TQ deflation. Significant correlations were observed between ischemia interval and, respectively, oxygenation recovery time (r2=0.84) and changes of deoxygenated hemoglobin (r2=0.57).

**Conclusion:** We demonstrated that, following TQ inflation and deflation respectively, NIRS can sensitively monitor muscle deoxygenation and reoxygenation. Consistent patterns of ΔHbHb and ΔO2Hb occurred during TQ-induced ischemia in all subjects. These data confirm that near infrared spectroscopy is useful for the non-invasive detection and monitoring of muscle ischemia. These results indicate that it may be useful to investigate the efficacy of NIRS in the early detection of muscle ischemia or hypoxemia in conditions such as compartment syndrome. FUNDING: MSFHR, COF, BC Lung.

**29 - The Role of Hemarthrosis in Joint Contractures**

**Kevin A Hildebrand, AB; Michael J Monument, AB;**

**Purpose:** The presence of hemarthrosis during joint injury is a potential inciting stimulus in the genesis of joint capsule fibrosis. Using a rabbit model of posttraumatic knee joint contracture, our hypothesis was that, bone marrow-derived elements of hemarthrosis rather than simply the presence of blood in the joint, trigger the induction of capsule fibrosis in post-traumatic joint contracture.

**Method:** 35 Skeletally mature New Zealand White female rabbits (12-18 months old, 5.5 ± 0.5 kg) were randomly assigned to one of five groups: Immobilization-Only (IMO), Immobilization+ Bone Marrow (IMBM), Immobilization+ Peripheral Blood (IMPB), Bone Marrow-Only (BMO), and Controls. Surgeries: Immobilization groups had one knee joint fixed at full flexion with a Kirschner wire drilled through the tibia, passed posterior (extra-articular) to the knee joint and bent around the femur. Bone marrow groups had cortical windows removed from the non-articular cartilage portion of the medial and lateral femoral condyles. In the IMBM group, autologous peripheral venous blood was injected into the immobilized knee joint to recreate a non-traumatic hemarthrosis. The control group did not have any intervention. Joint angle measurements: After 8 weeks, rabbits were euthanized, all muscular tissue was removed and maximum extension angle of the joints with intact capsule was measured using a standard torque applied via a custom made rabbit knee gripping device attached to a MTS TestStar II. Each joint was cycled 5 times (0.2 Nm) and the average of 5 cycles was calculated. Statistical analysis consisted of a one-way ANOVA with posthoc Scheffe test (significance p < 0.05). Data are presented as mean +/- standard deviation.

**Results:** The IMBM (n=8) and IMPB (n=7) groups had significantly greater contractures (52 +/- 12 and 58 +/- 13 degrees, respectively) when compared to the BMO (n=7) and control (n=6) groups (32 +/- 10 and 32 +/- 13 degrees, respectively). The IMO group had average contracture measures of 44 +/- 15 degrees. There was no statistically significant difference between the IMBM and IMPB groups.

**Conclusion:** The present study showed differences in the contracture severity of the immobilized knees associated with hemarthrosis compared to other experimental and control groups. There does not appear to be a difference whether the hemarthrosis arose from a fracture (bone marrow) versus peripheral blood in rabbits. Future work will look at reversibility of contractures in the various groups. Studies on the joint capsule will evaluate myofibroblast numbers in concert with mast cell and neuropeptide distribution based on our previous work. Such knowledge will aid the prevention and treatment of the difficult and disabling problem of contracture formation after joint injury.

**30 - Polyethylene Wear in Total Knee Replacements is Sensitive to the Thermal Stability of Test Lubricants**

**Steven JM MacDonald, ON; Jan-Mels Brandt, MB; Kory Charron, ON; Lee-Ann Briere, MB; Lin Zhao, ON; John B Medley, ON;**

**Purpose:** Standardized guidelines for in-vitro wear testing of total knee replacements have recently been proposed (ISO-14243). Such ISO guidelines suggest the use of a protein-rich lubricant without giving ranges on the lubricants’ thermal stability. Thermal stability has not received much attention in implant wear testing, but is an important tribological characteristic of a lubricant. This study examines the thermal stability of human synovial fluid (SF) from patients with osteoarthritis, the thermal stability of three artificial lubricants and investigates their effects on PE wear.

**Method:** SF was aspirated from three patients undergoing primary total knee arthroplasty. Three artificial lubricants were mixed using iron-supplemented alpha-calf serum (ACS) as the protein-rich base-lubricant and were diluted with either distilled water (ACS + DW; osmolality = 145 ± 2.00 mmol/kg), phosphate-buffered saline (ACS + PBS; osmolality = 312 ± 1.00 mmol/kg), or with PBS an 1.5 g/L hyaluronic acid (ACS + PBS + HA; osmolality = 321 ± 2.64 mmol/kg). Differential scanning calorimetry was used to determine the thermal stability of the SF and all three artificial lubricants. A 5.5 Million cycle wear test was performed using an AMTI knee simulator to determine the effect of each artificial lubricants’ thermal stability on PE wear. Additional biochemical analyses included the assessment of protein degradation and the measurements of peptide concentration.

**Results:** The thermal stabilities were significantly different between all three artificial lubricants (ACS + DW < ACS + PBS < ACS + PBS + HA). The thermal stability of ACS + PBS + HA closely matched the thermal stability of SF. The PE wear rate for ACS + DW was
significantly higher than for ACS + PBS. Unexpectedly, the PE wear rate with ACS + PBS + HA was significantly higher than for ACS + DW and for ACS + PBS. Protein degradation and peptide concentration increased with increased thermal stability of the lubricant. **Conclusion:** Using ACS + PBS instead of ACS + DW increased the lubricants' osmolality, thus stabilizing the proteins by increasing the thermal stability of the lubricant which reduced the PE wear rate. ACS + PBS + HA increased the lubricants' thermal stability, which closely matched the thermal stability of SF, and such an increase accelerated the PE wear rate. It was proposed that HA formed a protein-HA network which reduced the lubricating ability of ACS + PBS + HA compared with ACS + PBS, leading to increased protein degradation and increased peptide concentration and thus accelerating the PE wear rate. The findings of the present study strongly suggested to revise ISO-14243 in its current form and to include recommendations on clinically relevant thermal stability levels for artificial lubricants used in in-vitro wear testing of total knee replacements.

**Paper Session #4 COA/CORS Combined Knee Arthroplasty**

**31 - Preoperative Muscle Activation Patterns Affect Implant Migration**  
**David AJ Wilson, NS; Cheryl Hubley-Kozey, NS; Michael J Dunbar, NS; Janie L Astephen Wilson, NS;**

**Purpose:** The goal of this study was to investigate if musculoskeletal activation patterns measured with electromyography (EMG) are predictive of migration of total knee replacements (TKR) measured with radiostereometric analysis (RSA).

**Method:** 37 TKR patients who were part of a larger randomized controlled RSA trial were recruited to this study. Study participants had been randomized to receive the Nexgen LPS Trabecular Metal tibial monoblock component (n = 19), or the cemented NexGen Option Stemmed tibial component (n = 18) (Zimmer, Warsaw IN). Ethics approval was received from the institutional review board. In the week prior to their surgery, the patients went to the dynamics of human motion laboratory and underwent EMG data collection. Surface electrodes were placed over the vastus lateralis, vastus medialis, rectus femoris, the lateral and medial hamstrings, and the lateral and medial gastrocnemius using standardized placements (Hubley-Kozey et al., 2006). The variability in subject EMG patterns was captured with a set of discrete scores that represented weightings on objectively-extracted features of the gait waveform data using principal component analysis (PCA). Within four days of surgery and at six months post-operatively, patients had bi-planar knee x-rays taken. RSA analysis was performed with MB-RSA (MEDIS, Leiden). RSA results were reported as maximum total point motion (MTPM), and six degrees of freedom translations and rotations at six months.

**Results:** A correlation was found between the third principle component of the lateral gastrocnemius muscle (representing high gastrocnemius activation in late stance) and the anterior migration of the component (R²=0.247 P<0.002). A correlation was found between the vastus medialis principle component three (representing low vastus medialis activation in late stance) and the anterior migration of the component (R²= 0.338, P=0.000). A stepwise regression model was developed for anterior migration of the tibial component. To reduce the number of terms in the model only the two EMG variables that were correlated with anterior migration, implant type and BMI were entered leaving four possible terms. The stepwise regression eliminated all variables but the lateral gastrocnemius and the vastus medialis. The regression equation was Anterior-Posterior Migration = 0.01 +0.12*Vastus Medialis PC3 + 0.074*Lateral Gastrocnemius PC3 (R²=0.487, R² Adj=0.457, P<0.0001)

**Conclusion:** It has previously been shown that anterior shear on the tibial component of TKR is temporally localized to the last third of stance phase of gait. Both the gastrocnemius and vastus muscle groups have the ability to produce large anterior posterior shear on the knee during late stance. This result shows that variables which capture the temporal activation patterns of these muscles preoperatively are related to the migration of the tibial component of TKR postoperatively. This may have implications for rehabilitation of these patients.

**32 - Randomised Clinical Evaluation of Bone Mineral Density Variation Using Cemented Titanium versus Non-cemented Trabecular Metal Tibial Base Plates in Primary Total Knee Arthroplasty**  
**Michèle Angers, QC; Etienne L Belzile, QC; Michel Malo, QC; Pascal-André Vendittoli, QC; Marc Bouchard, QC;**

**Purpose:** Bone stress transmission by an implant has been demonstrated to be inversely proportional to its rigidity. Since trabecular metal has a high elasticity modulus, it is hypothesised that it should have a preservative impact on bone mineral density (BMD) loss. No current studies prospectively compare BMD variations using such implants.

**Method:** A randomized study recruiting 65 patients with osteoarthritis of the knee, were assigned to a cemented titanium or a non-cemented trabecular metal tibial base plate. Each patient had a DXA scan of the proximal tibia on the TKA side at two weeks, six months, one and two years follow-up. Analytic methods for DXA scans were standardized (Variation coefficient=0.59-0.84%), and BMD variation compared between groups using the Student t-Test.

**Results:** Versus early post operative evaluation, BMD loss was found in the two groups. Fixed effects on BMD, such as patient's height (p<0.001) and tibial implant size (p=0.04) were demonstrated. Patella resurfacing and polyethylene thickness had no effect on BMD. BMD loss was more important under titanium implants (-30.9%) than trabecular metal implants (-6.3%). The most affected area was the metaphysis (p=0.002) compared to the diaphysis (p=0.054).

**Conclusion:** Trabecular metal tibial base plate seems to diminish BMD loss under tibial implant compared to traditional titanium base plate. A long-term study will be necessary to determine the tibial trabecular metal component survival rate.
33- Validation of Polyethylene Tibial Insert Wear Analysis Using Micro-computed Tomography
Matthew G Teeter, ON; Douglas D Naudie, ON; David D McErlain, ON; Jan-Mels Brandt, MB; Xunhua Yuan, ON; Steven JM MacDonald, ON; David W Holdsworth, ON;

**Purpose:** This study develops and validates a technique to quantify polyethylene wear in tibial inserts using micro-computed tomography (micro-CT), a non-destructive high resolution imaging technique that provides detailed images of surface geometry in addition to volumetric measurements.

**Method:** Six unworn and six wear-simulated Anatomic Modular Knee (DePuy Inc, Warsaw, IN) tibial inserts were evaluated. Each insert was scanned three times using micro-CT at a resolution of 50 µm. The insert surface was reconstructed for each scan through automatic segmentation and the insert volume was calculated. Gravimetric analysis was also performed for all inserts, and the micro-CT and gravimetric volumes were compared to determine accuracy. The utility of surface deviation maps derived from micro-CT was demonstrated by co-registering a worn and unworn insert. 3D deviations were measured continuously across the entire insert surface, including the articular and backside surfaces.

**Results:** The mean percent volume difference between the micro-CT and gravimetric techniques was 0.04% for the unworn inserts and 0.03% for the worn inserts. No significant difference was found between the micro-CT and gravimetric volumes for the unworn or worn inserts (P = 0.237 and P = 0.135, respectively). The mean coefficient of variation for volume between scans was 0.07% for both unworn and worn inserts. The map of surface deviations between the worn and unworn insert revealed focal deviations exceeding 750 µm due to wear.

**Conclusion:** Micro-CT provides precise and accurate volumetric measurements of polyethylene tibial inserts. Quantifiable 3D articular and backside surface deviation maps can be created from the detailed geometry provided by the technique. Compared to coordinate mapping, micro-CT provides 10 times greater surface sampling resolution (50 µm vs 500 µm) across the entire insert surface. Micro-CT is a useful analysis tool for wear simulator and retrieval studies of the polyethylene components used in total knee replacement.

34 - Revision Total Knee Arthroplasty for Component Malrotation is Highly Beneficial
David J Backstein, ON; Dror Lakstein, IL; Mohammad Zarrabian*, MB; Yona Kosashvili, IL; Yona Kosashvili, IL; Oleg Safir, ON; Allan E Gross, ON;

**Purpose:** Component malrotation is a recognized cause of post total knee arthroplasty (TKA) pain. The objective of this study was to evaluate the functional outcomes of TKA revision for component malrotation, and to compare it to revision surgeries for aseptic loosening as a control comparison group.

**Method:** Twenty four patients who had TKA revision due to component malrotation as the only objective abnormality were reviewed. Only patients with preoperative computerized tomography (CT) documentation of 3° or more malrotation of at least one of the components were included. Mean combined rotation was 6.8° (range, -12 – 3) excessive internal rotation. Twenty four matched control patients had TKA revision due to aseptic loosening.

**Results:** Mean follow up was 37 months (range, 24-65). Mean interval from index surgery was 41 months (range, 24-65) for the study group and 98 months (range, 11-222) for the control group (p=0.0003). Preoperative Knee Society Score (KSS) improved by 49 points (range, 16-80) at 6 months postoperatively for the malrotation patients and by 39 (range, -7-78) for the loosening patients (p=0.08). At last follow-up, KSS was 80 (range, 60-89) for the malrotation group and 75 (range, 26-90) for the loosening group (p=0.14).

**Conclusion:** We recommend the use of CT scans in evaluation of all patients with early painful TKA’s and no objective evidence of infection. When component malrotation is demonstrated, we believe the results of this study validate consideration of early revision.

35 - The Role of Genetic Variants in Predicting Response to Steroid Injections for Knee Osteoarthritis
Mark Gatha, NL; Frank Noffal, NL; Roderick D Martin, NL; Peter Rockwood, NL; Proton Rahman, NL;

**Purpose:** Intra-articular corticosteroid injections is a well established treatment for knee osteoarthritis (OA). However, only 60% of patients have a good short-term response and about 20% of patients have a satisfactory long-term response. Genetic variants may play a role in predicting response to corticosteroids. A genetic variant of the macrophage inflammatory factor (MIF) (a physiologic counter-regulator of glucocorticoids), has been associated with poor clinical response in various inflammatory diseases. No studies to date have evaluated the effect of this variant on steroid injections for knee OA. We set out to determine the impact of the -173(C) variant of the MIF gene on clinical response to intra-articular injections for knee OA.

**Method:** 80 patients with Kellgren-Lawrence Grade 2-3 OA of the knee were prospectively followed for three months following a standard dose of steroid injection. All patients were genotyped for the -173 variant of the MIF gene. WOMAC questionnaires for knee OA were done at baseline, one, four and twelve weeks to assess response to treatment.

**Results:** 21 patients (25%) carried the C allele of -173 variant of the MIF gene. At 12 weeks, patients with the C variant had a statistically significant decrease in the pain dimension of the WOMAC compared to the G variant. Similar responses were not obtained at weeks one and four.

**Conclusion:** A specific polymorphism in the MIF gene appears to be associated with a poor response to intra-articular knee injections. Further validation is required with larger sample sizes to assess the impact of prospectively genotyping for this variant prior to knee injections.

36 - The Synovial Fluid Adiponectin - Leptin Ratio Predicts Pain with Knee Osteoarthritis
**Purpose:** Obesity is known to be a risk factor for the incidence and progression of prevalent osteoarthritis (OA). The relationship is traditionally believed to be a mechanical effect on weight bearing joints such as the hip and knee, however studies showing a relationship between body mass index (BMI) and OA of non-weight bearing joints, such as the hand, suggest another theory. They suggest that the relationship between obesity and joint degeneration may be a systemic metabolic effect whereby visceral and subcutaneous truncal white adipose tissue (WAT) secrete inflammatory mediators that directly influence the pathogenesis of OA. We asked what is the relationship between adiponectin, leptin, and the A/L ratio and patient reported pain in an end stage knee OA joint population.

**Method:** We collected demographic data, Short Form McGill Pain scores, WOMAC pain scores, and synovial fluid (SF) samples from 60 consecutive patients with severe knee OA at the time of joint replacement surgery. Synovial fluid samples were analyzed for leptin and adiponectin using specific ELISA. Non-parametric correlations and linear regression modeling were used to identify the relationship between the adipokines and pain levels.

**Results:** The correlations between the individual adipokines and the pain scales were consistently less than that for the corresponding adipokine ratio. The A/L ratio correlated moderately with the MPQ-SF, (\(r(58) = -0.46, p < .01\)) and the WOMAC pain score, (\(r(58) = -0.38, p > .01\)). Linear regression modeling demonstrated that the A/L ratio was a significant predictor of a greater level of pain on the MPQ-SF (p = 0.03, Table 3) but not the WOMAC pain scale (p = 0.77, Table 4). Models were adjusted for age, gender, BMI, and medical comorbidity.

**Conclusion:** In conclusion, a greater A/L ratio predicted lower knee OA pain as measured by the MPQ-SF, but not on the WOMAC pain scale. This finding was above that of the individual adipokine levels alone. Some authors have suggested that leptin may have a proinflammatory role while adiponectin an anti-inflammatory role in synovial joint diseases. Further work to elucidate these pathways may present a target for novel therapeutics in knee OA.

**37 - The Role of Polyethylene Design on Post-op TKA Flexion: An Analysis of 1534 Cases**

**Richard W McCalden, ON; Steven JM MacDonald, ON; Kory D Charron, ON; Robert B Bourne, ON; Douglas D Naudie, ON;**

**Purpose:** The range of motion after TKA depends on many patient, surgical technique, and implant factors. Recently, high-flexion designs have been introduced as a means of ensuring or gaining flexion after TKA. We therefore evaluated factors affecting postoperative flexion to determine whether implant design influences long-term flexion.

**Method:** We prospectively collected data on patients receiving a primary Genesis II total knee replacement with a minimum of 1-year followup (mean, 5.4 years; range, 1-13 years). We recorded pre- and postoperative outcome measures, patient demographics, and implant design (cruciate retaining [CR, n = 160], posterior stabilized [PS, n = 1177], high-flex posterior stabilized [HF-PS, n = 197]).

**Results:** Backward stepwise linear regression modeling revealed the following factors that significantly affected postoperative flexion: preoperative flexion, gender, body mass index, and implant design. Independent of gender, body mass index, and preoperative flexion, patients who received a HF-PS and PS design implant resulted in 8° and 5° more flexion, respectively, than those who received a CR implant. Based on analysis examining preoperative flexion categories, patients with low flexion preoperatively (< 100°) were more likely to gain flexion, whereas those with high flexion preoperatively (> 120°) were most likely to maintain or lose flexion postoperatively. Controlling for implant design, patients with high flexion preoperatively (> 120°) were more likely to gain flexion with the HF-PS design implant (HF-PS = 32.0%; PS = 15.1%; CR = 4.5%).

**Conclusion:** In summary, our data demonstrate postoperative range of motion after TKA is related to several factors, confirming the important role of the patient’s preoperative range of motion. In addition, our review suggests knee design and, in particular, the use of a so called “high-flexion” PS polyethylene design may be advantageous in maintaining or improving flexion postoperatively, especially in those patients with good preoperative range of motion.

**38 - Evaluation of Reconstructive Surgery Using Artificial Ligaments in 56 Acute Knee Dislocations**

**Pierre Ranger, QC; Alexandre Renaud, QC; Philippe Dahan*, QC; Josee Delisle, QC; Eros De Oliveira Jr, BR; Philippe Phan, QC;**

**Purpose:** Knee dislocation, although very rare, remains a devastating injury with many complications because of the complex nature of this trauma. The best treatment for knee dislocation is yet to be determined. The purposes of the study were to describe our surgical method, to report our results and to compare them with those of other surgical reconstruction techniques for knee dislocation.

**Method:** Fifty-six (56) patients with knee dislocation underwent acute combined reparation and reconstruction using Ligament Advancement Reinforcement System (LARS) artificial ligament. Patients were divided in three different groups according to the follow-up period. Group 1 (G1) included patients with a follow-up between two and six months post-op, group 2 (G2) involved patients with a follow-up between six months and twenty-four (24) months and group 3 (G3) was composed of patients who had a follow-up between twenty-four (24) and ninety-one (91) months.

**Results:** There was a significant difference between G1 and G3 for the Lysholm score and for the posterior stability at 90° of flexion measured with the Telos.

**Conclusion:** The subjective and objective findings from our series are satisfactory and comparable to the results of other series of knee dislocations. Our findings suggest that with a follow-up at seven years, acute combined reparation and reconstruction with LARS ligaments is a valid alternative for the treatment of knee dislocation.
39 - Mean 20 Years Follow Up for Distal Femur Fresh Osteochondral Allografted Patients - Prospective Study
Guy Raz, ON; Oleg Safir, ON; Paul Lee, ON; Oren Ben Lulu, ON; David J Backstein, ON; Allan Gross, ON;

**Purpose:** An Osteochondral defect in the knees of young active patients represents a challenge to the orthopedic surgeon. Early studies on allogenic cartilage transplantation showed this tissue to be immunologically privileged, showed fresh grafts to have hyaline cartilage, and surviving chondrocytes present several years after implantation.

**Method:** Since January 1978 until October 1995 we enrolled 72 patients in a prospective non-randomized study of fresh osteochondral allografts in our institute. Ten international patients which were lost to follow-up were excluded. The major indications for the procedure were: patients younger than 60 years of age having post-traumatic unipolar defects larger than three cm in diameter and one cm in depth.

**Results:** Sixty two patients, ages 11-57 (mean 28) were followed for 15-31 years (mean 20.4 years). The etiology for the osteochondral defect was traumatic injury to the knee in 41 patients (66%), Osteochondritis Dissecans in 15 patients (24%), and in six patients (10%) due to other pre-existing conditions. Twenty of the 62 grafts have failed, with five having graft removal and 15 converted to total knee replacement. Three patients died during the course of this study due to unrelated causes. The Kaplan-Meier survivorship analysis showed: 92%, 79%, 56%, and 49% graft survival at 10, 15, 20, and 25 years respectively, (median survival = 23 years). Patients with surviving grafts had good function, with a modified Hospital for Special Surgery score of an average 88 at 20 years or more following the allograft transplantation surgery.

**Conclusion:** Through this long term study the authors confirm the value of fresh osteochondral allografts as a long term solution for large articular defects in the knees of young patients. The improvement of patients’ outcome compared to the previous published results of our earlier studies could be attributed to improved surgical techniques and increasing expertise of the senior authors. We therefore recommend the use of fresh osteochondral allografts for treatment of large osteochondral defects in the distal femur of young and active patients.

40 - Total Knee Arthroplasty Alignment - Estimating the Mechanical from the Anatomic Axis
Theodore D Cooke, ON; Lisa Sheehy, ON; David Felson, MA;

**Purpose:** Coronal mal-alignment contributes to total knee arthroplasty (TKA) failure. The surgical aim is to place the implant at right angles to the load-bearing axis, restoring the femoral and tibial mechanical axes (MA) to neutral. Mal-alignment of greater than 3° is associated with a poor outcome and reduced longevity. Pre-operative decisions for alignment correction are often made using anatomical axis (AA) measurements taken from standing short knee radiographs. The aim of this study was to determine how well the AA predicts the MA in subjects with mild and severe varus and valgus deformities. Several different methods of calculating the AA were also compared for their ability to predict the MA.

**Method:** The database of full-length lower extremity radiographs from the Multicenter Osteoarthritis (MOST) Study was used to select images for this study. All of the subjects in the MOST either had knee OA or were at high risk for developing knee OA. 120 full-length digital radiographs were assigned, with 30 in each of four alignment groups (0° to 4.9°, and ≥ 5° of varus and 0.1° to 4.9°, and ≥ 5° of valgus). The MA and 5 measures of the AA (using progressively shorter shaft lengths) were obtained from each radiograph using Horizons Analysis Software, OAISYS Inc. The offsets between the MA and the different versions of the AA were calculated (95% confidence intervals) for the complete sample of 120 limbs and for each alignment group. Pearson correlations were also calculated (α = 0.05).

**Results:** The average offset between the MA and the AA for the entire dataset was 5.0°. In varus limbs the shortened shaft AA measurements increased the offset from 5.1° to 7.0°. The opposite occurred with valgus limbs (from 5.0° to 3.7°). The CI for the offsets increased from less than 3° for the full-length AA measurements to over 8.3° for the shortest AAs. While correlations between MA and AA for the whole dataset were high (0.88 to 1.00), correlations for individual groups were much lower, especially for the shortest AA (0.41 to 0.66).

**Conclusion:** Using short knee radiographs to estimate the MA has important limitations. The offsets obtained using the shorter AAs vary depending on type and degree of mal-alignment, and do not provide reliable predictions for the MA. Full-length films are needed to consistently define the alignment in order to ensure the best outcome from TKA.

**Paper Session #5 COA Critical Issues**

41 - (Sample) Size Matters! The Risk of Stopping Orthopaedic Trials Too Early
Emil H Schemitsch, ON; Mohit Bhandari, ON; SPRINT Investigators, ON;

**Purpose:** Failure to adequately recruit patients in orthopaedic trials has often led to early stopping and publication of research findings from smaller sample sizes than originally planned. The purpose of this study is to demonstrate the effect of sample size in a large, clinical trial by using SPRINT trial data to evaluate the results that would have been reported if the trial were stopped at various enrollments.
Method: The SPRINT trial evaluated reamed vs. unreamed nailing in 1226 tibia fractures. We analyzed the re-operation rates after various increments in sample size and compared the early results that would have been reported at smaller enrollments with those seen in the final, adequately powered study.

Results: In the final analysis of 1226 patients, there was a significant reduction in the risk of re-operation with reamed nails for closed fractures (35% reduction; p=0.02) and a trend towards an increased risk of re-operation for open fractures (23% increase; p=0.26). In stark contradiction, the results for the first 50 patients enrolled in the trial revealed a substantial increased risk for reamed nails in closed fractures (risk increase: 165%). It was not until enrollment reached 800 patients that the results reflected the final findings of an advantage for reamed nails. In open fractures, the trend favoring unreamed nails was not seen until 200 patients had been enrolled.

Conclusion: Our findings suggest that stopping the SPRINT trial early would have led to misleading estimates of the treatment effect between reamed and unreamed nails.

42 - The Influence of Hip Motion on the Functional Centre of Rotation
Daniel Varin, ON; Andrew Speirs, ON; Daniel Benoit, ON; Melanie Beaulieu, ON; Mario Lamontagne, ON; Paul E Beaulé, ON;

Purpose: A functional centre of rotation (CoR) is often required in biomechanical analysis of the hip or as a landmark in computer guided surgery. It was previously shown that circumduction motions predict a CoR that is inferior and lateral to the geometric centre of the hip bearing surfaces. It is therefore necessary to establish the best method for determining the CoR to improve surgical planning. The objective of this study was to compare the predicted CoR from circumduction and star motions, and to compare these to the geometric centre of the joint.

Method: Eight cadaveric hips from four cadavers were tested. Prior to testing, CT scans of the cadavers were made from the iliac crest to the tibial plateau; the alpha angle for all hips was less than 50° so all hips were considered 'normal'. Reflective marker arrays were rigidly mounted on the femoral diaphysis and iliac spine using 4mm Steinman pins. A five-camera Vicon system (Oxford, UK) was used to track the motions of the arrays during manipulation of the lower limb. To determine the functional hip centre, trials consisting of five cycles each of circumduction, flexion-extension and abduction-adduction were performed on each lower limb; three trials of each motion were performed. The range of motion was approximately 45° in the coronal and sagittal planes. For the 'star' motion, the flexion-extension and abduction-adduction trial data were combined. Following the trials the hip was dissected to expose the articular surfaces of the femoral head and acetabulum. These surfaces were traced using a pointer equipped with reflective markers to determine the geometric centre. To calculate the functional centre, the 3D coordinates of the markers were used to construct a local-to-global 3D transform for each frame throughout the trial. The geometric centre was calculated using a least-squares sphere fit (Gauss-Newton) of the trace data, calculated in the respective local coordinate systems. The coordinates of the functional centres were then transformed to an anatomic coordinate system, using the geometric centre as the origin. All calculations were performed using Matlab (Mathworks, Inc, MA, USA). A t-test was performed in each anatomic direction to detect differences in CoR predicted by the two motions.

Results: Both the circumduction and star motions resulted in a similar CoR. Differences were 0.41±2.25mm in the anterior-posterior direction; 0.09±0.72mm in the superior-inferior direction; and 0.21±0.82mm in the medial-lateral direction, none of which were significant (p>0.5). The overall mean distance between the CoR predicted by the two motions was 2.0±1.3mm. The functional centre was also found to be lateral and inferior to the geometric centre, and was consistent for each motion. Results for the acetabulum showed similar trends.

Conclusion: This study has shown that circumduction and star motions are equivalent in predicting the hip functional CoR; differences were small compared to the dimensions involved in studies such as gait analyses. However, both motions predicted a CoR that was inferior and lateral to the spherical centre of the femoral head, suggesting that the hip does not act as a true ball-and-socket joint with congruent spherical bearing surfaces. This may have important consequences in studies at the scale of the hip joint, especially for pathological conditions such as femoroacetabular impingement.

43 - Clinical Outcome Following Knee Disarticulation
John J Murnaghan, ON; Karen Fairley, ON; Ramez Hanna, ON;

Purpose: To determine the wound healing rate, perioperative mortality and ambulatory status of patients following knee disarticulation.

Method: Methods: Retrospective review of all cases performed by one surgeon at tertiary center. Charts reviewed for demographic data, surgical and follow-up data. Ambulatory status preop and postop graded after Volpicelli et al. Descriptive statistics applied.

Results: Results: 34 knee disarticulations in 28 patients. 3 perioperative deaths (11%). Report on 31 procedures in 25 patients with mean follow-up of 7 months. 20 males, 5 females. Mean age 73 (55-92). PVD 21/25. Diabetes Mellitus 13/25 (52%). Chronic infection 2, Scleroderma 1 and squamous cell carcinoma 1. Primary wound healing 25 (81%). Delayed healing 6 (19%). Reoperation 1. Revision of amputation 0. Mean ambulatory status preop 2.5/6. Mean ambulatory status postop 1.8/6.

Conclusion: Conclusion: Knee disarticulation is a reliable surgical procedure with 81% primary healing in high risk population. Knee disarticulation should be considered as an option to above knee amputation for patients with PVD and complications of diabetes.

44 - Increasing the Response Rate to Surveys: How Important is Academic Prestige to Orthopaedic Surgeons?
Brad Petrisor, ON; Mohit Bhandari, ON; Bauke W Kooistra, ON; Bernadette G Dijkman, ON; Sheila Sprague, ON;
**Purpose:** To investigate (1) if adding the prospect of co-authorship to a survey’s final paper would increase, and (2) if the sending modality (fax or email) would affect, the six-week response rate of an orthopaedic survey.

**Method:** We identified orthopaedic surgeons through the internet-based Orthopaedic Trauma Association member list. All surgeons received the same questionnaire. In a factorial randomized, controlled fashion, they were allocated (1) to receive or not receive an additional cover page promising co-authorship of the survey’s final paper if they filled in and returned the survey (an “academic incentive”), and (2) to receive their survey by fax or email.

**Results:** For 429 surveyed surgeons, six-week response rates were similar for surgeons in the incentive- and no-incentive groups (36.8% vs. 35.4%, respectively, p=0.39). Similarly, response rates did not significantly differ between emailed and faxed surgeons (32.9% vs. 39.9%, respectively, p=0.13). The mean time to response seemed shorter in the incentive-group than in the no-incentive group (p=0.058).

**Conclusion:** We cannot recommend promising co-authorship to increase the response rates of surveys to orthopaedic surgeons. Additionally, emailed and faxed surveys yielded statistically similar response rates, leaving the decision regarding what modality to employ to time and money constraints.

### 45 - The Effect of Surgeon Fatigue on Hip and Knee Arthroplasty

**David W Walmsley,** ON; **Christopher Peskun,** ON; **James P Waddell,** ON; **Emil H Schemitsch,** ON;

**Purpose:** There is growing support in the medical literature that patient outcomes are adversely affected by physician fatigue in operator-dependent cognitive and technical tasks. The recent increase in total joint arthroplasty case load has resulted in longer operative days and increased surgeon fatigue. The purpose of this study was to determine if time of day predicts perioperative outcomes and complications in total hip and knee arthroplasty surgery.

**Method:** The records of all primary Total Hip Arthroplasty (THA) and Total Knee Arthroplasty (TKA) surgery performed for primary osteoarthritis, during 2007 at one large university hospital, were retrospectively reviewed. Complete demographic data (age, gender, Body Mass Index), start time of surgery, intraoperative complications, duration of surgery, radiographic component alignment, and functional outcome scores (SF-12 and WOMAC) for 341 THA and 292 TKA patients were collected and analyzed using linear and nonparametric rank correlation statistics. Data was corrected for gender, body mass index (BMI), surgeon, and post-call operating days.

**Results:** In the THA cohort, a later start time of surgery was significantly related to duration of surgery (p=0.0013). In addition, there was a trend towards significance for intraoperative femur fracture (p=0.0542) later in the day. Postoperative complications, component alignment, and functional outcome scores were not significantly affected by start time of surgery. There were no significant findings for any of the intraoperative or postoperative outcomes in the TKA cohort.

**Conclusion:** This study demonstrates that duration of surgery and the incidence of intraoperative complications for THA may increase as the start time of surgery becomes later in the day. These findings should be taken into consideration when planning operative days involving THA.

### 46 - Validity of the Quality of Recovery-40 Questionnaire (QoR-40) in Patients Undergoing Total Knee or Hip Arthroplasty

**Paul E Beaulé,** ON; **Stephane Poitras,** ON; **Geoffrey F Dervin,** ON;

**Purpose:** The Quality of Recovery-40 questionnaire (QoR-40) has been developed, validated and extensively used to assess the quality of life of patients following major surgery. It is composed of 40 questions answered by the patient and organized into six dimensions: emotional state, physical comfort, psychological support, physical independence, pain, and global score. However, this questionnaire has not been validated in an orthopaedic population. The objective of the study was to assess the psychometric properties of the QoR-40 in a population of patients undergoing total knee or hip arthroplasty.

**Method:** Sixty seven patients undergoing total knee arthroplasty and 65 patients undergoing total hip arthroplasty were recruited. Patients were assessed with the QoR-40 and the SF-12, a validated generic quality of life questionnaire, at the following seven times: three and one week pre-operative; one, two and three days post-operative (short-term); one and three months post-operative (long-term). The following psychometric properties of the QoR-40 were assessed: reliability between three and one week pre-operative using intra-class correlation coefficients (ICC), construct validity with the SF-12 using Pearson product moment correlations, responsiveness to change using effect sizes, floor and ceiling effects, and predictive validity of short-term QoR-40 scores of long-term SF-12 scores.

**Results:** All dimensions and global scores of the QoR-40 appeared reliable, with ICCs' ranging from 0.75 to 0.84. For construct validity, physical dimension scores of the QoR-40 (physical comfort, physical independence, pain) were weakly or not significantly related to the physical component scale of the SF-12 (-0.09 to 0.34), except for long-term where the correlations were moderate (0.35 to 0.62). The emotional state score of the QoR-40 was moderately to substantially related to the mental component scale of the SF-12 for all periods (0.40 to 0.78). Effect sizes were higher for the QoR-40 when compared to the SF-12 in the intervals of the first month, while they were higher for the SF-12 in the intervals above one month. The QoR-40 demonstrated ceiling effects for the physical independence dimension pre-operatively and three months post-operatively, and for all periods for the psychological support dimension. As for predictive validity, short-term post-operative QoR-40 scores were weakly or not significantly predictive of long-term post-operative SF-12 scores (0.01 to 0.41).

**Conclusion:** The QoR-40 appears to be a reliable tool assessing a quality of life construct different from the SF-12 and more responsive to change during the short-term follow-up to surgery. The QoR-40 could be used to assess short-term quality of life following
surgery. The QoR-40 should not be used to predict long-term quality of life. To further improve the tool, the psychological support dimension of the QoR-40 should be reconceptualized because of ceiling effects.

47 - Estimating Patient Recruitment in Orthopaedic Randomised Controlled Trials
Nicole Simunovic, ON; Mohit Bhandari, ON; Bauke W Kooistra, ON; Bernadette Dijkman, ON;

Purpose: Estimating recruitment for clinical trials is vital to ensuring the feasibility of larger multi-centre trials. We compared estimates of potential recruitment from a prospective eight-week screening study and a retrospective chart review across sites participating in three fracture management trials.

Method: During the planning phase of two multi-centre, randomized controlled trials regarding the operative treatment of hip (two studies) and tibial shaft (one study) fractures, 74 clinical sites provided estimates of the annual recruitment rate both retrospectively (based on chart reviews) and prospectively. The prospective estimate was generated by screening all incoming patients for eligibility in the concerning trial, without actually enrolling any patient, for eight weeks. These prospective and retrospective estimates were correlated with each other (for 74 sites) and with actual one-year recruitment rates in the definitive trial (for nine sites).

Results: On average, a centre’s prospective estimate was only slightly lower than its retrospective estimate (3.1 patient-difference, p=0.64). Both predictions were substantial overestimations of recruitment in the definitive trial; only 31% (95% confidence interval: 28%-35%) of retrospectively estimated patients and 34% (95% confidence interval: 30%-37%) of prospectively estimated patients were recruited in the definitive trials (p<0.001 and p=0.001 for both overestimations, respectively). The overall costs of conducting retrospective chart reviews and prospective screening studies in 65 sites were $68,107 ($CAN) and $153,725 ($CAN), respectively.

Conclusion: Compared to relatively simple and inexpensive chart reviews, prospectively screening for eligible patients at clinical sites did not result in more accurate predictions of accrual in large randomized controlled trials.

48 - Patient Concerns About Undergoing Elective Musculoskeletal Surgery
Rajiv Gandhi, ON; Yoga R Rampersaud, ON; Nizar N Mahomed, ON; Pamela Hudak, ON; Christian Veillette, ON; Khalid Syed, ON; Steve Lewis, ON; J Roderick Davey, ON;

Purpose: Factors influencing patient willingness to undergo elective surgery are poorly understood.

Method: We prospectively evaluated patient concerns prior to surgical consultation for elective spinal, hip, knee, shoulder/elbow (S/E), or foot/ankle (F/A) conditions. Patients were surveyed for demographic data, SF 36 quality of life (QOL) scores and asked to report their greatest concern about considering surgery for their condition, as well as their willingness to undergo surgery if it was offered to them by their treating surgeon.

Results: In our prospective cohort of 743 patients, 364 (51%) were male and 293 (39 %) were evaluated for a spine condition, 74 (10 %) hip, 192 (26 %) knee, 69 (9 %) S/E, and 115 (16 %) F/A. Mean QOL scores were similar for patients across specialties. The top three greatest concerns for undergoing elective musculoskeletal surgery were potential complications (20%), effectiveness (15%) and recovery time (15%) of surgery. When categorized by specialty, concern of surgical complications was the most prevalent in spine (23%) and F/A patients (30%). However, patients were most commonly unsure of risks associated with their respective subspecialty surgery (spine -56%; hip - 53%; knee -44%; S/E – 48% and F/A – 33%). The majority of hip patients (89%) perceived a high success rate for hip surgery, while 65% of spine patients where unsure of the success of spine surgery. Patient willingness to undergo surgery was greatest for hip (84%), knee (78%), and S/E (82%) surgery and least for spine (68%) and F/A surgery (74%).

Conclusion: Although patient willingness to consider surgery is clearly a multifactorial decision, patient perception of surgical risk or success prior to surgical consultation are significant factors.

49 - Forecasting and Persuading in Orthopaedic Surgery: Delivering Non-surgical Treatment Recommendations
Pamela Hudak, ON; Shannon Clark, ON; Geoffrey Raymond, US;

Purpose: Only 30% or less of patients who see an orthopaedic surgeon are surgical candidates. Thus, orthopaedic surgeons’ role in the management of musculoskeletal conditions is wider than surgery and, accordingly, their treatment recommendations include much more than surgery as well. This paper examines the delivery of recommendations not for surgery (NFS) in routine orthopaedic surgery consultations.

Method: Audio-recordings of routine consultations between 121 patients and 14 surgeons from two tertiary care hospitals in a large Canadian city were collected and analyzed using Conversation Analysis, a rigorous, empirical approach to the study of interaction which seeks to reveal sequential structures and patterns in naturally occurring talk, and to explain why these patterns are important.

Results: In contrast to recommendations for surgery, which tend to be delivered fairly quickly and straightforwardly, the delivery of NFS recommendations tends to be elaborate and complex. Orthopaedic surgeons recurrently utilize a cluster of interactional devices in the lead-up to NFS recommendations, including: 1) projecting turns – turns which indicate that the surgeon will produce an extended turn; 2) parenthetical remarks – self-qualifying remarks inserted into a turn underway; 3) ‘brightsides’ – comments which emphasize something positive about the patient’s case or condition; 4) syllogisms – turns which allow patients to make logical deductions about the nature of the recommendation to come; and 5) usual case or general course descriptions. Additionally, even though surgery is not being recommended, NFS recommendations are positioned in relation to surgery. Surgeons use this cluster of devices to manage a range of competing demands, for example, showing that they are taking the patient’s problem seriously, being attentive to the patient’s
treatment expectations, explaining the rationale for the recommendation, and positioning the recommendation not for surgery in relation to surgery – e.g., explaining why surgery is not being recommended now, and/or the conditions under which surgery would be offered in the future. Through this cluster of devices, surgeons forecast the nature of the recommendation to come, lay bare the evidential basis for the recommendation and work to obtain patients’ subsequent acceptance of the recommendation. The cluster, as a whole, constitutes a persuasive argument for the upcoming recommendation.

Conclusion: Delivering not for surgery recommendations is a complex task, one which surgeons handle skillfully using several interactional devices. Surgeons treat these recommendations as requiring a persuasive case. An appreciation for the complexities and constraints of delivering NFS recommendations can be used to inform clinical practice and the teaching of communication skills.

50 - Knowledge and Attitudes in the Clinical Identification of Violence Against Women: A Survey of Surgeon Members of the Orthopaedic Trauma Association
Sheila Sprague, ON; Gregory Della Rocca, US; Sonia Dosanjh, ON; Emil H Schemitsch, ON; Mohit Bhandari, ON;

Purpose: In recent years, there has been an increased appreciation of the importance of intimate partner violence (IPV), which is also known as domestic violence, spouse abuse, and battering, as a serious public health problem. Domestic violence is the most common cause of nonfatal injury to women in North America. As providers of musculoskeletal care and first-contact health care practitioners for many patients, orthopaedic surgeons should be knowledgeable regarding screening and possible interventions for IPV victims. The Canadian Orthopaedic Association and the American Academy of Orthopaedic Surgeons have both prepared explicit statements that orthopaedic surgeons should play a role in the screening and appropriate identification of victims of IPV. We aimed to identify the knowledge, attitudes, and beliefs about IPV among orthopaedic surgeons who are members of the Orthopaedic Trauma Association.

Method: We surveyed members of the Orthopaedic Trauma Association to identify attitudes toward IPV by posting a survey on the Orthopaedic Trauma Association website for its membership to complete. The survey consisted of three sections: (1) the general attitude of the orthopaedic surgeon toward intimate partner violence, (2) the attitude of the orthopaedic surgeon toward victims and batterers, and (3) the clinical relevance of intimate partner violence in orthopaedic surgery.

Results: One-hundred-and-fifty-three orthopaedic surgeons responded. The majority of the respondents were male (99%) with practices in North America (96%). Surgeons underestimated the prevalence of IPV in their practices and communities and manifested several key misconceptions: 1) victims must be getting something out of the abusive relationships (16%); 2) some women have personalities that cause the abuse (20%); and 3) the battering would stop if the batterer quite abusing alcohol (40%). In the past year, approximately half of the surgeons (50.8%) acknowledged identification of a victim of IPV; however, only 4.0% of respondents currently screened for IPV among female patients with injuries. Surgeons expressed concerns about lack of knowledge in the management of abused women (30%) Guidelines for the detection and management of IPV were uncommon in most surgeons’ practices (7.8%).

Conclusion: There is a strong rationale for addressing IPV as an issue that is relevant to the field of orthopaedic surgery just as it has been shown to be relevant to primary care, emergency medicine, and obstetrics and gynecology. Our study found that orthopaedic surgeons underestimated the prevalence of IPV in their practices, held multiple misperceptions about IPV, and demonstrated discomfort in identifying and treating IPV. Targeted educational programs on IPV are needed for surgeons who routinely care for injured women.

Paper Session #6 CORS Spine & Biology of Arthritis

51 - Automated Quantitative Analysis of Metastatic Disease in Rat Spine: The Effects of Stereological Model and Spatial Resolution
Seyed-Parsa Hojjat, ON; Cari M Whyne, ON;

Purpose: To examine the effect of image resolution and structural model on quantifying architectural differences between healthy and metastatically involved vertebrae.

Method: Lumbar vertebrae of healthy(n=6) and metastatically involved(n=6) mnu/mu rats were utilized. Osteolytic vertebral metastases were developed via intracardiac injection of human MT1 breast cancer cells. µCT images of the vertebrae were acquired ex vivo at 14μ isotropic spatial resolution. The whole vertebrae were segmented using an automated atlas based demons deformable registration followed by level set curvature evolutions. A subsequent iteration of level set was used to yield a segmentation of the trabecular centrum. The individual trabecular network was further segmented using intensity based thresholding. Architectural parameters were computed from the segmented µCT images: Cortical Bone Volume(CBV), Trabecular Bone Volume(TBV), Trabecular Bone Surface Area and the degree of anisotropy based on Mean Intercept Length(MIL). From this, trabecular Thickness(TbTh), Trabecular Number(TbN) and Trabecular Separation(TbS) were calculated using the Parfitt Model (Parfitt, Bone & Mineral. 1987). TbTh was also calculated separately using the Hilderbrand model (Hilderbrand, J of Microscopy 1997). The degree of anisotropy was determined via Mean Intercept Length (MIL) measured utilizing a binary shift/subtraction approach. The measures of TbTh and MIL were compared for each image at 8.725(high), 17.45(medium) and 34.9(low) μm3 isotropic spatial resolutions.

Results: Parfitt’s plate model showed a significant decrease in TBV, TbN and CBV and a significant increase in TbS in the metastatic vertebrae in comparison to the healthy group at the highest resolution. In both Hilderbrand’s and Parfitt’s models at the highest resolution there was no significant difference in TbTh between the healthy and metastatic groups. In both models, TbTh and TbS values
rose while TBV and TbN decreased as the resolution was lowered. Significant reductions were observed only in TbTh between the healthy and metastatic vertebrae at the medium and low resolutions. In all cases, the Hildebrand model yielded lower values of TbTh than the Parfitt model. However, achieving robust automated results using the Hildebrand method was limited in the final stage of the segmentation due to sensitivity to small islands of bone. Structural anisotropy remained consistent in all groups at all resolutions, with ~3x greater MIL in the superior/inferior direction. The degree of anisotropy was, however, consistent in both groups suggesting that the metastatic destruction does not have any directional preference.

**Conclusion:** The automated use of Parfitt’s plate model along with the MIL method can be used to yield quantitative analyses demonstrating differences in vertebral microstructure due to metastatic involvement. However the sensitivity of these architectural parameters to resolution motivates the need for high resolution scanning in future preclinical applications.

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**52 - Increased Phosphorylation of ERK and p38 Signal Transduction Proteins in Mesenchymal Stem Cells From Osteoarthritic Patients**

**Fackson Mwale,** QC; Guoying Yao, QC; Alain Petit, QC; John Antoniou, QC;

**Purpose:** Mesenchymal stem cells (MSCs) from osteoarthritic (OA) patients are not well characterized and little is known of how they are regulated. Recent evidence indicates that a major drawback of current cartilage and intervertebral disc (IVD) tissue engineering is that human MSCs from OA patients express type X collagen (COL10), a marker of late-stage chondrocyte hypertrophy (associated with endochondral ossification). However, the intracellular pathways for transducing signals that regulate hypertrophy in MSCs remain unclear. In chondrocytes, this pathway is mediated by mitogen activated protein kinase (MAPK) p38. The aim of this study was to determine the phosphorylation levels of ERK/p38 MAPK signaling molecules in MSCs from OA patients compared to those from normal patients.

**Method:** MSCs were obtained from aspirates from the intramedullary canal of donors (60-80 years of age) undergoing total hip replacement for OA. Cells were cultured in DMEM high glucose supplemented with 10% fetal bovine serum, 100 U/ml penicillin, and 100 µg/ml streptomycin for 2-3 passages. Cells were then lysed and proteins were separated on 10% acrylamide gels and transferred to nitrocellulose membranes. Protein expression was determined by Western blot using specific antibodies directed against type X collagen, ERK, phosphorylated-ERK, p38, phosphorylated-p38, JNK, phosphorylated-JNK, AKT, and phosphorylated-AKT. GAPDH was used as a housekeeping gene. Proteins were detected using the West Pico Chemiluminescence substrates and analyzed using the Bio-Rad VersaDoc equipped with a cooled CCD 12 bit camera. Normal mesenchymal stem cells from a 22 years old woman were purchased from Lonza (Switzerland).

**Results:** Results show that the expression of COL10 was markedly increased in MSCs of OA patients compared to control patient. Results also show that the phosphorylation of all the signal transduction proteins studied was induced in MSCs of patients with OA. Indeed, the phosphorylation of ERK (3.4±0.9 times the control), p38 (1.7±0.3 times the control), JNK (5.4±1.14 times the control), and AKT (4.3±0.8 times the control) was higher in MSCs of OA patients compared to control normal patients.

**Conclusion:** In the normal donor, MSCs continue to exhibit their in situ behavior in that they expressed very little or no COL10. This may relate to the fact that normal MSCs being multipotent in nature like to maintain an undifferentiated state. In contrast, MSCs from OA patients expressed COL10: this suggests that they are in a situation were they can be preprogrammed not only to replace the degenerated articular cartilage but also the damaged subchondral bone. Since the phosphorylation of ERK/p38 MAPK signaling molecules is also lower in normal MSCs, our results also suggest that this signaling pathway is implicated in the control of COL10 expression. This finding is of great importance for the understanding of COL10 regulation in general and may lead to important advances in the comprehension of COL10 related diseases.

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**53 - Assessment of Hepatic Inflammation After Spinal Cord Injury Using Intravital Microscopy**

**Hans Hundt,** ON; Jennifer Fleming, ON; Abdel Lawendy, ON; Kevin Gurr, ON; Stewart I Bailey, ON; David Sanders, ON; Greg McGarr, ON; Relka Bihari, ON; Christopher S Bailey, ON;

**Purpose:** Recent studies have examined the systemic inflammation that occurs following spinal cord injury (SCI) (Gris et al. 2008). It is believed that this systemic inflammation plays a role in the respiratory, renal and hepatic morbidity of SCI patients, ultimately contributing to mortality post-injury. Evidence of this inflammatory response has been shown as early as two hours post SCI (Gris et al. 2008) Intravital microscopy is a powerful tool for assessing inflammation acutely and in 'real-time' (Brock et al. 1999). This tool would be useful for demonstrating the acuteness of a systemic inflammatory response post-SCI, and for assessing the degree of inflammation to different severities of SCI. The liver has been shown to play a particularly important role in the initiation and progression of the early systemic inflammatory response to spinal cord injury (SCI), therefore the purpose was to evaluate hepatic inflammation immediately after SCI. We hypothesized that SCI would cause immediate leukocyte recruitment and that the magnitude of inflammation would increase with increasing severity of cord injury.

**Method:** Male Wistar rats (200-225g) were randomly assigned to one of the following groups: uninjured, trauma-injured (laminectomy and no cord injury), cord compressed or cord transected. Spinal cord-injured rats were anesthetized by isoflurane, a dorsal laminectomy was performed, and the 4th thoracic spinal segment was injured by a moderately severe clip-compression injury or by a severe complete cord transection injury. Uninjured rats and trauma-injured rats served as controls. At 0.5 and 1.5 h after SCI rats had the left lobe of their livers externalized and visualized using intravital video microscopy.
Results: At 0.5 hours the total number of leukocytes per post-sinusoidal venule was significantly increased after cord compression and cord transection compared to that in uninjured and trauma-injured rats (p<0.05). Of these leukocytes significantly more were either adherent or rolling along venule walls compared to uninjured and trauma-injured rats (p<0.05). Of the rolling leukocytes 2–fold more were observed after cord transection compared to cord compression. At 1.5 h the total number of leukocytes per post-sinusoidal venule and the number of adherent leukocytes was significantly increased only after cord transection.

Conclusion: Injury to the spinal cord but not trauma alone causes immediate leukocyte recruitment to the liver within 0.5 h after injury. Also, leukocyte recruitment increases with increasing severity of injury. This is the first study to use intravitral microscopy to visualize systemic inflammation in the liver following SCI.

54 - Outcome of Photodynamic Therapy on Breast Cancer Metastases in Vertebralae of Rats Pre-treated with Bisphosphonates
Margarete K Akens, ON; Emily Won, ON; Lisa Wise-Milestone, ON; Brian C Wilson, ON; Albert JM Yee, ON; Cari M Whyne, ON;

Purpose: Bony metastases in vertebralae secondary to breast cancer can result in osteolysis and an increase in skeletal related events. Bisphosphonates (BP) are the current standard of care for breast cancer patients with skeletal disease. Photodynamic therapy (PDT) is a non-radioactive treatment, which has been successfully applied to various malignancies and shown to successfully ablate vertebral human breast cancer (MT1) metastases in a murine model. Previous in-vitro studies have shown that pre-treatment of MT-1 cells with the BP zoledronic acid (Zometa®) renders them more susceptible to PDT. The aim of this study was to evaluate the influence of pre-treatment with BPs on the effect of PDT treatment on tumour ablation in metastatically involved vertebralae in vivo.

Method: Metastases were induced in fourteen 5-6 weeks old female athymic rats (Hsd:RH-Foxn1nu) by intra-cardiac injection of 2x10^6 MT-1 cells. Four groups were formed: 1.control, no treatment; 2.BP only; 3.PDT only; 4.BP and PDT combined. Seven days after MT-1 injection 60 µg/kg of zoledronic acid was injected. PDT treatment was administered on day 14 using the photosensitizer BPD-MA (1.0 mg/kg; Visudyne). Fifteen minutes later, laser-light (690nm; 75J) was administered to the lumbar vertebralae. The rats were euthanized 7 days after PDT treatment. A total of 45 vertebralae were evaluated using a histomorphometric program (GENIE™, Aperio) to assess tumour burden. Statistical analyses were performed using a one-way ANOVA with a Tukey post hoc test. A p-value p<.05 was considered to be statistically significant.

Results: The total tumour burden within vertebralae of rats pre-treated with BP and/or PDT was significantly lower compared to the control rats (p<.001). In addition, the PDT alone treated group demonstrated significantly less tumour burden than the combined BP+PDT group. In the control and BP-only groups, large tumours were found to include regions of necrosis. The PDT treatment groups (PDT and BP+PDT) exhibited areas of necrosis throughout the entire vertebral bodies with adjacent formation of granulation tissue. Conclusion: BP, PDT and combined BP+PDT treatments resulted in a lower overall tumour burden at day 21 post MT-1 cell injection compared to control rats. A surprising increased level of tumour burden was found in comparing the combined treatment group to the PDT-only group. These findings are in contrast to previous in-vitro results, where the pre-treatment with BPs made the cells more susceptible to PDT. Pre-treatment with BP affects both the bone and tumour cells, and as such may induce different cellular pathways in response to PDT treatment. However, the ability of PDT applied at day 14 to cause a similar reduction in tumour burden compared to BP treatment at day 7, suggests its ability to rapidly and effectively ablate the tumour within the bone, even in the presence of BP.

55 - Characterization of Novel Culture Conditions which Prevent Articular Chondrocyte Dedifferentiation
Randy DC Barley, AB; Keith M Bagnall, AB; Nadr M Jomha, AB;

Purpose: Traditionally, chondrocyte growth and characterization studies have been conducted using non-physiologic, normoxic, monolayer culture systems that have the major drawback of dedifferentiation. Recently, however, the use of novel 3D culture systems, cytokine supplementation or hypoxic culturing techniques have shown that chondrocyte dedifferentiation can be greatly reduced. Unfortunately, to date, no single culture technique has been identified that completely prevents the dedifferentiation-related changes in ECM gene expression. We hypothesized that combining a high density culture condition with an hypoxic environment would improve chondrocyte phenotype retention as determined by gene expression and protein production when compared to current standard culture conditions.

Method: Freshly isolated normal human articular chondrocytes were maintained in three culture conditions: 1) conventional monolayer culture, 2) high density monolayer culture (HDMC) and 3) embedded in alginate and compared to freshly isolated positive controls (FIC) and fibroblasts as negative controls. The conventional monolayer cultures were harvested at confluence while HDMC and alginate-embedded chondrocytes (AEC) were maintained in culture for 8 weeks. Parallel experiments were conducted under normoxic (21% O2) and hypoxic (5% O2) conditions for all three experimental groups. Chondrocytes were harvested, RNA was extracted and quantitative RT-PCR was performed using primers for collagens (I, II, VI, IX and XI), aggrecan, SOX-9, HIF-1, 3 different integrins and GAPDH. In addition, collagen and GAG content was quantified when possible using Sircol and Blysacn assays respectively.

Results: HDMC cultures in hypoxic conditions showed a 2.5 fold increase in wet weight, a 6.9 fold increase in GAG content and a 1.3 fold increase in collagen content relative to normoxic HDMCs. With respect to gene expression levels, only the HDMCs in hypoxic culture conditions yielded mRNA expression levels of collagen II, IX, XI, aggrecan, HIF-1, SOX-9 and one Integrin that were consistent with the levels seen in freshly isolated chondrocytes (positive control). Importantly, HDMC culture in hypoxic conditions also yielded the lowest levels of collagen I of any experimental condition.

Conclusion: This research demonstrated that high density monolayer culture in hypoxic conditions prevented the severe loss of chondrocyte phenotype typically associated with conventional monolayer culture. Cells cultured in these conditions demonstrated gene
expression levels similar to those seen in FICs, which are superior to those seen following conventional culture conditions such as the use of alginate beads. These culture conditions provide a novel opportunity to maintain chondrocyte phenotype over a prolonged period of time while generating extracellular matrix that may be beneficial for treatment of full thickness cartilage defects.

56 - Effect of Link-N on Disc Repair in a Rabbit Model of Intervertebral Disc Degeneration

**Fackson Mwale, QC; Laura M Epure, QC; Tomoaki Yoshikawa, US; Aseem Hemmad, US; Megan Bokar, US; Koichi Masuda, US; Peter J Roughley, QC; John Antoniou, QC;**

**Purpose:** Intervertebral disc (IVD) degeneration is associated with proteolytic degradation of proteoglycan aggregates present within the extracellular matrix of the disc. Link-N peptide is the N-terminal peptide of link protein, which stabilizes the proteoglycan aggregates. It is generated in vivo by proteolytic degradation during tissue turnover. We have previously shown that this peptide can stimulate the synthesis of proteoglycans and collagens by IVD cells in vitro. However, to date, there have been no reports on the effect of Link-N on the IVD in vivo. The purpose of the present study was to determine the effect of intradiscally administration of Link-N peptide on disc cell survival and extracellular matrix synthesis using a rabbit annular needle puncture model of IVD degeneration.

**Method:** Twelve New Zealand white rabbits (~3.5 kg; 5-6 months old) received an annular puncture with an 18-gauge needle on 2 non-contiguous discs (L2-L3 and L4-L5). The disc (L3-L4) between the punctured discs and that above (L5-L6) was left intact as internal controls. Two weeks after the initial puncture, the anterior surfaces of the previously punctured discs (L2–L3 and L4–L5) were injected with either saline (10 µl/disc) or Link-N (100 µg in 10µl saline/disc) into the center of the NP. Disc height was radiographically monitored biweekly. After 12 weeks post-injection, all the rabbits were euthanized and the IVDs from both experimental groups were removed from each lumbar spine for biochemical analysis. The nucleus pulposus (NP) was separated from the annulus fibrosus (AF), the specimens weighed (wet weight), the content of DNA measured using PicoGreen, and the total contents of sulfated glycosaminoglycans (GAG) measured by the 1,9-dimethylmethylene blue (DMMB) assay.

**Results:** Following needle puncture that initiates disc degeneration, the disc height index (DHI) decreased by about 25%. By 6 weeks after Link-N injection, the mean percent DHI of injected discs in the Link-N group was higher than in the saline group. This difference in mean percent DHI was maintained during the rest of the follow-up. Puncturing the IVD also led to a decrease in proteoglycan content in both the NP and AF in saline-treated discs. Treatment with Link-N stimulated proteoglycan synthesis (GAG) in both the NP and AF by about 20%. Link-N did not cause an increase in the DNA content of the discs.

**Conclusion:** Results of the present study show that Link-N can stimulate proteoglycan production in vivo when administered to degenerate disc. This stimulation occurs in both the NP and AF of the disc and in the absence of any effect on cell division. The changes observed with Link-N on proteoglycan synthesis are similar to those reported after injection of osteogenic protein-1 (OP-1). Thus, Link-N appears to be equally effective at stimulating repair of the IVD in vivo. One major advantage of Link-N over OP-1 for therapeutic use is the large saving in cost, Link-N being about 400 times cheaper than OP-1.

57 - Differentiation of Mesenchymal Stem Cells from Osteoarthritic Patients on Nitrogen-rich Cell Culture Coatings

**Sonia Rampersad, QC; Alain Petit, QC; Guoying Yao, QC; Amélie St-Georges-Robillard, QC; Juan-Carlos Ruiz*, QC; Michel R Wertheimer, QC; John Antoniou, QC; Fackson Mwale, QC;**

**Purpose:** Several studies have been directed toward using mesenchymal stem cells (MSCs) from osteoarthritic (OA) patients for cartilage or disc repair because these patients are the ones that will require a source of autologous stem cells if biological repair of tissue lesions is to be a therapeutic option. A major drawback of current cartilage and intervertebral disc tissue engineering repair is that these cells rapidly express type X collagen, a marker of late stage chondrocyte hyper trophy implicated in endochondral ossification. However, a novel plasma-polymerized thin film material, named nitrogen-rich plasma-polymerized ethylene (PPE:N), is able to inhibit type X collagen expression in committed MSCs. The specific aim of this study was to determine if the suppression of type X collagen by PPE:N is maintained when MSCs are transferred to pellet cultures in chondrogenic defined media.

**Method:** MSCs were obtained from aspirates from the intramedullary canal of donors undergoing total hip replacement for OA using a protocol approved by the Research Ethics Committee of our institution. Cells were then expanded for 2-3 passages in DMEM high glucose supplemented with 10% fetal bovine serum, 100 U/ml penicillin, and 100 µg/ml streptomycin, and finally cultured on polystyrene (PS) cell culture dishes or PPE:N surfaces for 3 and 7 days. Cells were transferred for 3 additional days in a chondrogenic serum free media (DMEM high glucose supplemented with 2 mM L-glutamine, 20 mM HEPES, 45 mM NaHCO3, 100 U/ml penicillin, 100 µg/ml streptomycin, 1 mg/ml bovine serum albumin, 5 µg/ml insulin, 50 µg/ml ascorbic acid, 5 ng/ml sodium selenite, 5 µg/ml transferrin) in pellet culture or on PS cell culture dishes. Cells were then lysed and proteins were separated on 4-20% acrylamide gels and transferred to nitrocellulose membranes. Type X collagen was detected by Western blot; GAPDH expression was used as an internal control for protein loading.

**Results:** Results showed that type X collagen protein was expressed in MSCs from OA patients cultured on polystyrene but was suppressed when cultured on PPE:N. Since defined chondrogenic medium are commonly used in pellet culture to promote in vitro chondrogenesis, we then investigated the effect of transferring cells pre-cultured on PPE:N into pellet culture on type X collagen expression. However, the decreased type X collagen expression was not maintained in these conditions and that the expression returned to control values. The decreased type X collagen expression was maintained when the cells were cultured on PS cell culture dishes.
Conclusion: The use of MSCs is promising for tissue engineering of cartilage and intervertebral disc. The present study confirmed the potential of PPE:N surfaces in suppressing type X collagen expression in MSCs from OA patients. However, when MSCs stem cells are transferred to pellet cultures, type X collagen is rapidly re-expressed suggesting that pellet cultures may not be suitable for chondrogenesis of MSCs from OA patients.

58 - A Biomechanical Model of Degenerative Spondylolisthesis: Results of Pure Shear Testing
Angela Melnyk, BC; Stephen P Kingwell, ON; Qianing Zhu, Guangdong; Jason Chak, BC; Marcel F Dvorak, BC; Thomas R Oxland, BC;

Purpose: At present there is no reported, valid and reproducible model of degenerative spondylolisthesis for biomechanical testing of spinal implants. The purpose of this study was to create a single functional spinal unit (FSU) model that could demonstrate anterolisthesis consistent with low grade degenerative spondylolisthesis under physiologic shear loads.

Method: Eight fresh-frozen human cadaveric, lumbar FSU's were potted and secured in a custom jig for pure shear testing. The cranial segment was loaded from -50N (posterior) to 250N (anterior) over three cycles for each of five test conditions with a 300N preload. Test conditions addressed known restraints to shear translation and were performed in the same order for all specimens, and included: intact, facet capsulotomy and bilateral two mm facet gap, bilateral four mm facet gap, nucleotomy, and annular release. Three-dimensional motion was recorded using an optoelectronic camera system.

Results: Mean anterior translation at 250N for the five test conditions was 0.7 mm (95% confidence interval 0.4 to 0.9), 1.2 mm (0.9 to 1.6), 1.5 mm (1.1 to 2.0), 1.9 mm (1.4 to 2.4) and 3.1 mm (2.2 to 4.0). The mean maximum anterior translation was significantly different for each test condition with two exceptions. The four mm facet gap did not result in a significantly different maximum anterior translation compared to the two mm facet gap or the nucleotomy. There were no differences in off-axis motion (lateral or superior-inferior translation, flexion-extension, axial rotation, lateral bending) between the five test conditions.

Conclusion: Anterior translation consistent with low grade degenerative spondylolisthesis was repeatedly demonstrated under physiologic shear loads using this model. All sequential destabilizations preserved anatomy critical for the application of pedicle screw constructs, interbody devices and interspinous spacers. As such, this model is appropriate for biomechanical testing of implants currently used in the treatment of low grade degenerative spondylolisthesis.

59 - Effect of PTH on Type X Collagen Expression in Mesenchymal Stem Cells from Osteoarthritis Patients
Fackson Mwale, QC; Alain Petit, QC; Guoying Yao, QC; John Antoniou, QC;

Purpose: A major drawback of current cartilage and intervertebral disc tissue engineering is that human mesenchymal stem cells (MSCs) from osteoarthritis (OA) patients express type X collagen (COL10), a marker of late-stage chondrocyte hypertrophy (associated with endochondral ossification). Parathyroid hormone (PTH) and parathyroid hormone-related peptide (PTHrP) regulate endochondral ossification by inhibiting chondrocyte differentiation toward hypertrophy. In the present study, we investigated the effect of PTH on the expression of COL10 in MSCs from OA patients and analyzed the potential mechanisms related to its effect.

Method: MSCs were obtained from aspirates from the intramedullary canal of donors (60-80 years of age) undergoing total hip replacement for OA. Cells were cultured for 2-3 passages in DMEM high glucose supplemented with 10% fetal bovine serum, 100 U/ml penicillin, and 100 µg/ml streptomycin. Cells were then incubated for 0-24h without (Control) or with 100 nM PTH (1-34). Cells were lysed and proteins were separated on 10% acrylamide gels and transferred to nitrocellulose membranes. Protein expression was detected by Western blot using specific antibodies directed against COL10, p38, phosphorylated-p38 (p-p38), SAP/JNK, phosphorylated-SAP/JNK (p-JNK). GAPDH was used as a housekeeping gene. Protein levels were analyzed using a Bio-Rad VersaDoc equipped with a cooled CCD 12 bit camera.

Results: Results showed that PTH inhibited in a time-dependent manner the expression of COL10 in MSCs from OA patients. The level of expression decreased 21% of control (79% inhibition) after 24h. This inhibitory effect of PTH was reversed by Calphostin C, an inhibitor of protein kinase C. To further investigate the mechanism of action related to the effect of PTH on COL10 expression, we measured the phosphorylation of p38 and showed that PTH also inhibited this phosphorylation, which is an indicator of its activity. The level of phosphorylation reached 74% of control after 3h and stayed stable thereafter. Similarly, treatment of MSCs with PTH suppressed the phosphorylation of JNK, another major stress-activated MAP kinase. The level of phosphorylation reached 65% of control after 6h and returned to control values after 24h.

Conclusion: Results of the present study suggested that PTH may be a potential regulator of COL10 expression in MSCs from OA patients. Results also suggested a role for the protein kinase C and the p38/JNK pathways in this regulation. p38 and JNK are serine and threonine protein kinases that are activated by osmotic pressure, stress, and cytokines. It is therefore not surprising that their activities were elevated as OA (degenerative joint disease) is a result of trauma or infection to the joint and is characterized by an up-regulation of cytokines. Further studies are however necessary to better understand the role of these molecules in hypertrophy.

Paper Session #7 COA Knee Reconstruction

60 - Relationships Among BMI, Self Reported Complications, Functional Outcomes and Satisfaction Following Elective, Primary Hip and Knee Replacement: Results from a Canadian Regional Joint Replacement Registry
Lynda Loucks, MB; Eric Bohm, MB;
**Purpose:** There remains some debate over the impact of obesity on complications and function following total joint replacement. The purpose of this study was to examine the relationship between BMI, self-reported complications, function, and satisfaction using data from a large prospectively collected dataset.

**Method:** A total of 5364 procedures with complete one year post-operative data were obtained from a Canadian joint replacement registry for analysis. Self-reported complications after one year included re-operation, DVT, PE, dislocation and infection requiring antibiotics. BMI was classified as either non-obese (BMI≤30kg/m2). Satisfaction was collapsed into dichotomous categories: satisfied or unsatisfied. Pre and post-operative scores from the Oxford 12 were also included.

**Results:** The mean age of the total hip replacement (THR) group was 67.1 yrs (+/-11.8) with a mean BMI of 29.8 (+/-6.4). The total knee replacement (TKR) group’s mean age was 68.2 yrs (+/-9.99) with a mean BMI of 33.0 (+/-7.0). Ninety percent (90.6%) of THR patients were satisfied one year after surgery compared to only 81.9% of TKR patients (p<0.0001). For TKR patients, larger BMI was associated with both satisfaction and self-reported complications; obese patients reported being satisfied 82.4% of the time versus non-obese at 76.9% (p=0.037). Complication rates for obese TKR patients were 11.9% and 7.9% for non-obese (p=0.064). For THR patients, a similar relationship did not exist between BMI and satisfaction; however, it was observed for complications. Obese patients reported a complication rate of 7.4% versus 4.2% (p=0.02) for non-obese. Improvements in Oxford 12 scores were noted across all groups; mean improvement was 22 points in the THR group and 15 points in the TKR group, irrespective of BMI. Improvements in Oxford 12 scores were associated with complications; THR patients reporting complications showed mean improvements of 17 points versus 23 for those who did not (p<0.0001). TKR patients reporting complications had mean improvements of 10 points versus 16 for those who did not (p<0.0001). Satisfaction was also related to Oxford 12 score; THR patients who were unsatisfied demonstrated an Oxford 12 improvement of only 9 points versus 24 points for the satisfied patients (p<0.0001). Unsatisfied TKR patients demonstrated an improvement of only 4 points compared to 18 points for satisfied patients (p<0.0001).

**Conclusion:** THR patients were younger and more satisfied than TKR patients. There appears to be a positive relationship between BMI and complication rates for both TKR and THR. A larger BMI was related to increased satisfaction in TKR, it was unrelated in THR. Satisfaction was related to degree of functional improvement which, in turn, was curtailed by complications. It is therefore prudent to advise patients to reduce BMI prior to surgery to mitigate complications; however superior or equivalent satisfaction rates and positive functional improvement can be expected post surgery.

61 - Hypoxemia as an Indicator for Pulmonary Embolism in the Acute Post-arthroplasty Patient
Frank N Schnell, AB; Stephen D Miller, AB;

**Purpose:** This study was designed to evaluate post-total joint arthroplasty patients who were sent for a chest CT scan in order to determine the clinical factors that were most likely to be associated with, and predictive of, a radiologic diagnosis of pulmonary embolism in the acute, postoperative period.

**Method:** The current study involved a review of 540 total knee replacements and 543 total hip arthroplasty procedures performed from June 2008 to September 2009. All patients received postoperative VTE prophylaxis using LMWH, as per the protocols established by the Alberta Bone and Joint Initiative, and consistent with the recommendations of the American College of Chest Physicians (2008). A pulmonary CT scan was ordered for patients in situations where 1) a pulmonary embolism was strongly suspected 2) for those who lacked a clear alternative diagnosis as an explanation for their findings 3) when steps to correct the suspected underlying condition failed to normalize results, or 4) in situations where the diagnosis (i.e. new-onset atrial fibrillation) warranted further investigation to rule out a PE as a possible cause. Patients referred for multidetector computed tomography to investigate the possibility of pulmonary embolus were identified, and subjected to a chart review.

**Results:** Forty-two patients underwent a pulmonary CT scan investigation to rule out pulmonary embolus. Of these, 15 patients had undergone hip surgery, and 27 had undergone a total knee replacement. Of the 42 patients, 34 exhibited hypoxemia as their major presenting sign (oxygen saturation less than 90% on room air), with or without other signs or symptoms. Four patients presented with tachycardia alone, and 2 patients presented with chest pain, of which one patient had an associated arrhythmia. Of the 34 patients presenting with unexplained postoperative hypoxemia, 25 were patients who had undergone total knee replacement, and of these 25 patients, 14 (56%) were found to have a pulmonary embolus on CT scanning of the lungs. There were no PEs identified in the post-hip population. None of the patients with PE’s presented with subjective dyspnea or chest pain. There were no fatalities as a result of PE.

**Conclusion:** The overall high rate of detection of pulmonary embolism in our postoperative population is due the very close monitoring of pulse oximetry combined with the improved sensitivity of imaging modalities. Hypoxemia is emerging as the clinical sign that is most sensitive to the possibility of a PE in the post-knee arthroplasty patient. Reliance on clinical symptoms such as chest pain, dyspnea, or even tachycardia is no longer appropriate. It is recommended that oxygen saturation, as measured by pulse oximetry, should be monitored regularly on all post-arthroplasty patients. Hypoxemia should lead to a prompt and thorough medical workup. If an obvious explanation for the hypoxemia cannot be identified, the patient should undergo a multidetector CT scan to rule out a pulmonary embolus.

62 - Mid to Long-term Survivorship of the AMK Total Knee Arthroplasty System. A Comparison of Methods of Fixation
James P McAuley, ON; Kory D Charron, ON; Cecil H Rorabeck, ON; Robert B Bourne, ON; Steven JM MacDonald, ON;

**Purpose:** The purpose of this study was to investigate the mid to long term (minimum 10 years follow-up) survivorship of the AMK total knee arthroplasty (TKA), as well as determine the effect of implant fixation on outcome.
Method: Between 1988 and 2000, 1074 AMK primary total knee arthroplasties were preformed on 843 patients. All diagnosis included, the distribution was 90% osteoarthritis (971), 7% inflammatory arthritis (76) and 3% other diagnoses (27). Average time from surgery was 15 years (range 10-21 years). Average age at primary procedure was 68 years (range 22-99). Fifty-six percent were female (599) and 44% male (475). Preoperative alignment consisted of 56% varus (601) and 17% valgus (182). Ninety percent (968) had patella resurfacing performed, 62% (661) received cemented TKA fixation, on 32% hybrid fixation (cemented femoral component, cementless tibial tray) was performed and 6% (66) had cementless fixation. Two hundred thirty-seven cases were deceased before 20 years follow-up (22%).

Results: At 10 to 21 years follow-up, 129 revisions were performed (12%). The most common reasons for revision were polyethylene wear, particle induced osteolysis, instability and pain (43% of revisions). Implant fixation significantly influenced the rate of revision with cemented fixation having a 6.7% rate of revision (44/661), hybrid fixation a 14% revision rate (47/336) and cementless a 36.4% revision rate (24/66). Excluding infections (11 cases), overall Kaplan-Meier survivorship at five, 10 and 15 years was 96.4%, 91.9% and 85.8%, respectively. At 20 years the predicted Kaplan-Meier survivorship was estimated at 83.5% (no revisions beyond 17.5 years). Cemented fixation was associated with significantly better survivorship than hybrid and cementless fixation (p<0.0001). At 5, 10 and 15 years cemented AMK TKA survivorship was 97.5%, 94.9% and 91.9% respectively (no revision performed beyond 13.5 years). For hybrid fixation the survival at 5, 10 and 15 years was 97.8%, 92.2% and 85.1% respectively. Cementless AMK THA had a Kaplan-Meier survivorship of 88.9%, 78.2% and 57.4% at 5, 10 and 15 years respectively.

Conclusion: Cemented fixation had superior outcomes compared to cementless and hybrid fixation with the most common reasons for revision being polyethylene wear and osteolysis. To our knowledge this the first medium to long term follow-up of the AMK TKA and it demonstrates that method of fixation had a major influence on revision rates and survivorship.

63 - A Randomised Clinical Trial Comparing Patellar Resurfacing Versus Patellar Retention in Total Knee Arthroplasty
Charles C Secretan, AB; Lauren Beaupre, AB; D. William C Johnston, AB; Guy Lavoie, AB;

Purpose: Despite the excellent results of total knee arthroplasty (TKA), controversy over whether or not to resurface the patella persists. Anterior knee pain, which occurs with variable frequency, continues to be a problem in a subset of the TKA patient population. Some clinicians advocate resurfacing all patellae while others cite the complications attributed to patellar resurfacing as reasons to avoid this aspect of the procedure. Still others favour selective resurfacing based on subjective criteria. To address this clinical controversy, we prospectively randomized patients receiving TKA into two groups, those receiving patellar resurfacing and those left without resurfacing to determine clinical outcomes and revisions at five and 10 years postoperatively. Our primary objective was to compare the revision rate following TKA between the two study groups. Secondarily, we compared pain and function at five and 10 years and knee range of motion (ROM) over the first year.

Method: Patients receiving TKA were prospectively enrolled in the study and randomized intraoperatively to either receive patellar resurfacing or have no patellar intervention. All surgeries were performed through the standard medial parapatellar approach. The Smith and Nephew Profix TKA system was implanted in all cases and all subjects followed a standardized post-operative regimen. Subjects were assessed pre-operatively and at 6 months, 1, 3, 5 and 10 years postoperatively for knee ROM, function, and pain using the WOMAC and SF-36 questionnaires. Re-operations and revisions were also documented.

Results: Thirty-nine patients were enrolled in the study. There was 83% patient retention at five years and 74% at 10 years. Study groups were similar in baseline characteristics. At five years, three (18%) revisions had been performed in the retained patella group and one (5%) in the resurfaced group (p=0.31). There were no further revisions between five and 10 years. ROM was similar between the groups at all evaluations (p>0.05). SF-36 and WOMAC scores demonstrated that both groups improved their pain and function significantly following surgery (p<0.04).

Conclusion: The decision whether or not to resurface the patella during TKA remains controversial. This study demonstrated that initial results with either technique are comparable, but it appears that there may be clinically significant differences by five years postoperatively. These trends continued throughout the study and were statistically significant at the 10 year mark. Revision surgery was required in 18% of the retained group compared to 5% in the re-surfaced group.

64 - Hypoesthesia After Total Knee Arthroplasty: A Randomised, Controlled Trial Comparing Lateral Parapatellar to Mini Medial Incision in Total Knee Arthroplasty
Anna Potapov, QC; Pascal-André Vendittioli, QC; Jean-Michel Laffosse, QC; Martin Lavigne, QC; Michel Fallaha, QC; Michel Malo, QC;

Purpose: Antero-medial parapatellar skin incision in total knee arthroplasty (TKA) provides excellent surgical exposure with minimal skin incision length. However, it is associated with the infrapatellar branch of the saphenous nerve section, leading to antero-lateral knee hypoesthesia and sometimes painful nevroma. We hypothesized that A) antero-lateral skin incision in TKA produces a lower rate of hypoesthesia compared to the medial parapatellar cutaneous approach, and B) reduced hypoesthesia is linked with less discomfort and possibly a better clinical outcome.

Method: A total of 69 knees in 64 patients who underwent TKA were randomized for antero-medial (n=35) or antero-lateral (n=34) skin incision. Mean age was 66.4±8.2 years. Functional outcome was assessed by WOMAC, KOOS and SF-36 scores pre-operatively and at six weeks, six months and one year follow-up. Range of motion (active and passive flexion and extension) was measured. The area of hypoesthesia was analyzed in a standardized manner by an independent observer using a calibrated Semme-Weinstein monofilament applied on 13 reference points. A digital photograph was taken, and the area of hypoesthesia was then measured.
informatically (Mesurim Pro® software). Patient satisfaction with their scar and their surgery was evaluated. Statistical analysis was carried out with p<0.05 considered as significant.

**Results:** The two groups were comparable pre-operatively. There was no significant difference in functional outcome (WOMAC, KOOS, SF-36 scores) at six weeks, six months and one year between the two groups. Active and passive ranges of motion were comparable. The area of hypoesthesia and the number of non-perceived points in the monofilament test were significantly lower after antero-lateral incision at six weeks (p=0.007 and p=0.02, respectively) and 6 months (p=0.02 and p=0.005, respectively). At one year, the area of hypoesthesia was lower in the antero-lateral group, but was not significant (p=0.08). Antero-lateral incision patients reported a lower rate of subjective sensitivity loss and anterior knee pain at six weeks, six months and one year.

**Conclusion:** Antero-medial and antero-lateral parapatellar skin incisions in TKA have a similar functional outcome. However, antero-lateral cutaneous incision produces a lower rate of hypoesthesia and less anterior knee pain in the early recovery period.

65 - Effectiveness of a Medically Supervised Weight Loss Program in Improving Symptoms of Knee Osteoarthritis in Morbidly Obese Middle Aged Women

**Mark Harrison,** ON; Alice Aiken, ON; Brenda Brouwer, ON; Caroline Pukall, ON; Dianne Groll, ON;

**Purpose:** To determine the extent to which, a medically monitored rapid weight-loss program will improve pain, psychological status and functional abilities for morbidly obese women with knee osteoarthritis.

**Method:** 34 women (age 40 to 65) with morbidity obesity and severe osteoarthritis of the knee that presented to an orthopedic surgeon for total knee arthroplasty were offered enrollment into a medically supervised weight loss program prior to consideration of a total knee replacement. Twenty-six subjects chose to participate in the weight loss program. They were enrolled in the Dr. Bernstein diet program, (a low-calorie, low-fat diet) at no cost to them. We collected the following questionnaires at enrollment and every six weeks while they remained in the weight loss program: WOMAC, SF36, Self-Efficacy, Health Locus of control, Dieting beliefs scale, Body image state scale, and the Beck depression inventory as well as Functional tests, namely the Timed up and go (TUG) and 6 minute walk test (6MWT). Our hypothesis was that weight loss would be associated with dramatic improvements in pain, self-report quality of life measures, psychological variables, and measured functional abilities for those patients who were successful in the weight loss program.

**Results:** At enrollment the mean age was 58.5 years and mean BMI was 47.8.

Subjects were significantly disabled with WOMAC (total) scores of 48+/− 7 and impaired function in both the 6 minute walk test 229+/− 146 metres and the timed up-go test 5.9+/− 11.

<table>
<thead>
<tr>
<th>At Enrollment</th>
<th>3 Months</th>
<th>6 Months</th>
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<tbody>
<tr>
<td>(n=26)</td>
<td>(n=24)</td>
<td>(n=16)</td>
</tr>
<tr>
<td>BMI</td>
<td>46.7(8)</td>
<td>39.8(8)</td>
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<tr>
<td>Total WOMAC</td>
<td>54(18)</td>
<td>35(20)</td>
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<td>Pain WOMAC</td>
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<td>Mobility WOMAC</td>
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<td>24.8(14)</td>
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<tr>
<td>TUG (sec)</td>
<td>15.9(10.9)</td>
<td>11.0(3.5)</td>
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<tr>
<td>6MWT (m)</td>
<td>229(146)</td>
<td>316(123)</td>
</tr>
</tbody>
</table>

Subjects lost an average of 32 kilograms (range 14 to 50 kg) after six months of dieting.

Weight loss was associated with dramatic improvements in pain(p <.01), self-report quality of life measures (p <.01) and measured functional abilities (p <.01).

Successful weight loss was associated with patients’ self-report of no longer requiring TKA for their knee OA.

Initially 100% of subjects felt that they required surgery. This decreased to 9.5% after six months of weight loss.

**Conclusion:** A low-fat, low-calorie medically monitored weight loss program (Dr. Bernstein Diet Clinics Inc.) is effective for achieving significant weight loss in women with severe knee osteoarthritis and morbid obesity. Weight loss leads to significant improvements in pain and functional abilities and alleviates or delays the need for knee replacement surgery in the majority of middle-aged, morbidly obese women.

66 - Posterior Cruciate Preserving Versus Sacrificing TKRs: Is There a Difference Greater than 10 Years Follow-up?

**Robert Wallace,** ON; Robert B Bourne, ON; Richard W McCalden, ON; Steven JM MacDonald, ON; Kory D Charron, ON;

**Purpose:** There is no consensus whether the posterior cruciate ligament (PCL) should be preserved (CR) or sacrificed (CS) during primary total knee replacement (TKR). The purpose of this study was to compare the greater than 10 year survivorship and health related outcomes of CR and CS TKRs using a single implant system.

**Method:** Between 1996 and 2000, 478 Genesis II Primary TKRs were inserted in 414 patients. Excluding those with a primary diagnosis other than osteoarthritis, body mass index greater then 40, history of prior patellectomy, fusion or osteotomy, 358 cases in 310 patients were included. 134 (37%) had a PCL preserving (CR) and 224 (63%) had a PCL sacrificing implant (CS). The two patient cohorts were compared for Kaplan-Meier survivorship, health-related outcomes (Knee Society scores, WOMAC, SF-12), range of motion (ROM) and radiographic loosening or wear.
Results: Mean follow-up was 11.87±1.04 years for CR and 10.96±0.87 years for CS (p=0.001). Four cases were revised for infection. No significant differences were noted between the CR and CS Genesis II cohorts at 10 year Kaplan-Meier survivorship excluding infections (CR 0.984±0.011 , CS 0.986±0.008, p=0.30). Overall revisions were two for CR (1.5%, no infections) and seven for CS (1.7%, four for infection; 1.3% excluding infections). Revision rates were not significantly different between groups including or excluding infections (p=0.493 and p=1.00 respectively). CS had significantly greater postoperative ROM than CR (CS=114.20±13.60, CR=111.35±12.38, p=0.024). At 10 years, no differences were observed in satisfaction, health-related outcomes or radiographic wear/loosening. Crepitus was reported more frequently in CS design.

Conclusion: Most studies comparing PCL sacrificing (CS) versus retaining (CR) TKRs are short term. In this large, long term, single implant CR versus CS study, no differences were found in Kaplan-Meier survivorship, health-related outcomes or patient satisfaction. The CS design had more range of motion, but also a higher incidence of peripatellar crepitus than the CR design. We conclude that both CR and CS TKR designs can yield excellent long term clinical outcomes.

67 - A Randomised, Blinded Trial Comparing One HA Injection to Corticosteroid for Knee Osteoarthritis Pain
Ross K Leighton, NS; Kelly Trask, NS; Durolane Study Group, NS;

Purpose: INTRODUCTION: Intra-articular (IA) injections of corticosteroids and hyaluronic acid (HA) products are used to treat patients with knee osteoarthritis pain that has not responded to more conservative treatment. Corticosteroids are a standard of care despite only suggestive clinical evidence of 12 or more weeks of pain relief.

Method: METHODS: A double-blinded, randomized, active controlled, multicenter non-inferiority trial with 442 subjects provided a pragmatic comparison of HA to methylprednisolone. Both groups underwent one intrarticular injection, and underwent pain and function evaluations over 26 weeks. The primary endpoint for study success was WOMAC pain responder rate at 12 weeks. The outcome of two prior trials influenced the patient selection criteria and provided a saline cohort for propensity score analyses comparing HA and methylprednisolone to saline.

Results: The responder rate of HA was non-inferior to methylprednisolone at 12 weeks. Reductions in WOMAC pain, stiffness and physical function scores at all time points, and improvements in time to ‘get-up-and-go’ walk 10 meters occurred in both treatment groups. The trends favored the HA responder rates at the later time points while the methylprednisolone rate decreased significantly by 26 weeks. Propensity score analyses confirmed that the responder rates of methylprednisolone and HA were statistically significantly superior to a saline control at 12 weeks.

Conclusion: The responder rate from a single injection of HA was non-inferior to methylprednisolone at 12 weeks, and the trend favored HA at later time points. The responder rates of HA and methylprednisolone were statistically significantly greater than that of saline at 12 weeks.

68 - A Greater than 10-Year Follow-up Study Comparing Fixed Versus Mobile Bearing Total Knee Replacement Outcomes - Are They the Same?
Philip A O’Connor, ON; Robert B Bourne, ON; Steven JM MacDonald, ON; Richard W McCalden, ON; Cecil H Rorabeck, ON; Kory D Charron, ON;

Purpose: High contact stresses and wear after total knee replacement (TKR) has been a problem. Mobile bearing TKRs have been advocated as a means to increase load bearing area, reduce contact stresses and minimize wear. The purpose of this study was to compare two, large, consecutive cohorts of TKR patients with greater than 10 years follow-up, one with a fixed bearing and one with a mobile bearing design.

Method: One hundred and three SAL II mobile bearing TKR’s were compared to a gender, age, BMI and time from surgery matched fixed bearing Genesis II cohort of equal size. All surgeries were performed between September 1993 and December 2000 (average follow-up, 11.64±1.64 years). Inclusion criteria included patients with osteoarthritis of the knee. Exclusion criteria included revision arthroplasty, inflammatory arthritis, a prior osteotomy or a prior patellectomy. The >10 year Kaplan-Meier survivorship, health-related outcomes (Knee Society scores, WOMAC and SF-12), radiographs and retrieved implants for the fixed and mobile bearing TKR cohorts were compared.

Results: Fixed bearing TKRs demonstrated better 10 year Kaplan-Meier survivorships for any re-operation. 1.000±0.000 compared to 0.969±0.018 for mobile bearings (Genesis II and SAL II respectively). Revision rates were significantly different between groups with fixed bearing having no revisions and mobile four revisions (3.9%). No cases were revised for sepsis. Mobile bearing revisions were for pain (1), patellar maltracking (1), polyethylene wear (1) and aseptic loosening (1). At 10 years, health-related outcomes were similar between the two cohorts. Fixed bearing TKRs demonstrated more range of motion (111.42±12.76 vs 107.19±14.74 degrees) although not significant (p=0.052). Wear was more frequently noted in mobile bearing TKRs on >10 year radiographs.

Conclusion: In this comparison of two contemporary TKRs, the fixed bearing TKR outperformed the mobile bearing TKR.

69 - A Comparison of Computer Navigation to Extramedullary Guide Techniques Used to Produce Posterior Tibial Slope for Total Knee Arthroplasty
Paul RT Kuzyk, ON; Gordon Higgins, ON; James Tunggal, ON; Emil H Schemitsch, ON; James P Waddell, ON;

Purpose: The purpose of this study was to evaluate the accuracy and precision of 3 common methods used to produce posterior tibial slope during total knee arthroplasty.
Method: The study population consisted of 110 total knee arthroplasties in 102 patients that underwent total knee arthroplasty. All procedures were performed using a standard medial parapatellar approach and all knees were replaced using the Scorpio Knee System (Stryker, Mahwah, NJ) of implants and instruments. Three treatment groups were identified retrospectively based on the method used to produce the posterior tibial slope. Group 1 used an extramedullary guide with a 0 degree cutting block tilted by placing 2 fingers between the tibia and the extramedullary guide proximally and three fingers between the tibia and guide distally to produce a 3 degree posterior slope (N=40). Group 2 used computer navigation (Stryker Navigation System, Stryker, Mahwah, NJ) to produce a 3 degree posterior slope (N=30). Group 3 used an extramedullary guide placed parallel to the anatomic axis of the tibia with a 5 degree cutting block to produce a 5 degree posterior slope (N=40). Posterior tibial slope was measured from lateral radiographs by 2 independent reviewers that were blinded to the treatment group. The reported posterior tibial slope for each sample was an average of these two measurements. Accuracy of the treatment group was evaluated using a one sample t test. Groups 1 and 2 were tested for an ideal slope of 3 degrees, and Group 3 was tested for an ideal slope of 5 degrees. An a priori sample size calculation with α=0.05 and β=0.20 showed that at least 24 samples in each treatment group were required to determine a difference of 1.5 degrees between the treatment group mean posterior tibial slope and the ideal posterior tibial slope.

Results: The mean posterior slope measurements for treatment Group 1 (4.15±3.24 degrees) and treatment Group 2 (1.60±1.62 degrees) were both significantly different than the ideal slope of 3 degrees (p=0.03 for Group 1 and p<0.01 for Group 2). This indicates that treatment Groups 1 and 2 failed to accurately produce the ideal posterior tibial slope of 3 degrees. The mean posterior tibia slope of treatment Group 3 (5.00±2.87 degrees) was not significantly different than the ideal posterior tibial slope of 5 degrees (p=1.00). This indicates that Group 3 accurately produced the ideal tibial slope of 5 degrees.

Conclusion: The most accurate method to produce posterior tibial slope was the 5 degree cutting block with an extramedullary guide. Computer navigation had the lowest standard deviation and therefore was the most precise method. However, computer navigation was not as accurate in producing the desired posterior tibial slope as the extramedullary guide with the 5 degree cutting block. The manual method of producing tibial slope with an extramedullary guide and a 0 degree cutting block was the least precise method and not as accurate as the extramedullary guide with a 5 degree cutting block.

Paper Session #8 COA Hip Reconstruction

70 - A Randomised Trial to Evaluate the Clinical Effectiveness and Outcomes of the "Abductor Sparing" MIS Anterolateral Approach in Primary Total Hip Arthroplasty
Nelson V Greidanus, BC; Donald Garbuz, BC; Bas A Masri, BC; Allan Gross, ON; Michael Tanzer, QC; Clive P Duncan, BC;

Purpose: The purpose of this study was to evaluate the clinical effectiveness and outcomes of the 'abductor sparing' MIS Anterolateral approach (MIS Watson Jones/G3) in comparison to the MIS Direct Lateral and MIS Posterolateral approaches in primary total hip arthroplasty.

Method: A multicentre, prospective, randomized controlled trial was designed to evaluate for the superiority of the new MIS Anterolateral approach (MIS Watson Jones/G3). The sample size calculation was performed for alpha .05, power .90, to evaluate for effect size 0.5 in WOMAC using repeated measures analyses with baseline WOMAC as covariate. A total of 156 patients consented to participate in the trial and patients were assigned to MIS Anterolateral approach or alternate MIS approach (MIS Direct Lateral or MIS Posterolateral). Patients were subjected to standardized anesthetic and periooperative management protocols and were evaluated at standardized intervals to evaluate endpoints of early recovery (3 months) as well as endpoints of 12 and 24 months respectively. The primary outcome of interest was WOMAC, however secondary outcomes included SF-36, as well as parameters of health resource utilization and complications. Univariate and multivariate analyses were performed.

Results: Patient groups were found to be similar at baseline with regards to demographics and baseline quality of life outcomes (p>.05). Multivariate and repeated measures analyses demonstrated no superiority of the MIS Anterolateral approach on outcomes of WOMAC and other quality of life measures in comparison to MIS Direct Lateral and MIS Posterolateral approaches (p>.05). Health care resource utilization was also similar with length of stay, blood transfusion requirements and complications (p>.05).

Conclusion: Our multicentre, prospective, randomized clinical trial demonstrates that the MIS Anterolateral approach is not superior to alternate MIS surgical approaches when evaluating outcomes of quality of life, complications, and health resource utilization. Surgeons should consider these outcomes, complications, and other relevant advantages and disadvantages of select surgical approaches when deciding on a technique for use in their orthopaedic practice.

71 - RCT Comparison of Early Migration of Two Collarless Polished Cemented Stems Using RSA
Richard W McCalden, ON; Kory D Charron, ON; Xunhua Yuan, ON; Robert B Bourne, ON; Douglas D Naudie, ON; Steven JM MacDonald, ON; Abigail E Thompson, ON;

Purpose: The purpose of this prospective blinded randomized control trial was to compare the stem migration of two cemented stem designs using radiostereometric analysis (RSA). This was essentially a safety study in which our hypothesis was that the newer design (CPCS, Smith and Nephew Inc) would demonstrate similar micro-motion to the well-established Exeter (Stryker) design.

Method: Thirty patients were consented and enrolled into a blinded RCT in which 15 patients received a dedicated RSA CPCS stem and 15 patients received a RSA Exeter stem. Both stems are collarless tapered polished cemented stems, the only difference being a
slight lateral to medial taper with the CPCS design. Outcome measures were compared (Hip Society Score, WOMAC, SF-12). RSA analysis was conducted immediately post-operatively, at 6 weeks, 3 months, 6 months, 1 year and 2 years.

**Results:** No difference was found in any of the outcome measures pre-operatively or postoperatively. At 2 years, stem subsidence for the CPCS stem was approximately half that seen for the Exeter stem (0.565±0.189mm and 0.981±0.209mm respectively, p<0.0001). In contrast, posterior (internal) rotation of the CPCS was approximately twice that of the Exeter stem (1.496±1.215° and 0.716±0.818° respectively, p=0.221). Other migration patterns were no different between stems.

**Conclusion:** As expected with this stem design, both stems showed some axial and rotational migration within the cement mantle. The subtle differences in design may explain the differences in migration patterns. Our data suggests that the newer CPCS design should perform well over the long-term.

**72 - A Survey on the Incidence of Pseudotumours with MOM Hip Resurfacings in Canadian Academic Centres**

Paul E Beaulé, ON; Frank Smith*, ON; James N Powell, ON; John Antoniou, QC; Robert B Bourne, ON; Martin Lavigne, QC; Etienne Belzile, QC; Emil H Schemitsch, ON; Donald Garbuz, BC;

**Purpose:** Recently, there has been concern raised on the occurrence of pseudotumors after metal on metal hip resurfacing. A pseudotumor is defined as a local soft tissue mass associated with localized bony and/or tissue (muscle) destruction. The primary purpose of this study is to determine the incidence of this complication in several high volume Canadian academic centres.

**Method:** Nine of the 11 Canadian academic centres who perform metal on metal hip resurfacings were surveyed. The number of metal on metal hip resurfacing arthroplasties performed at each centre was first determined, as were the number of those who have presented with a pseudotumour, and subsequently gone on to revision surgery. The basic demographics of the group were recorded, as were the radiographic and implant design variables for those cases presenting with a pseudotumour.

**Results:** A sample of 3,400 hip resurfacing arthroplasties performed between 2002 and December 2008 were surveyed. Demographics were tabulated for a sub-sample of these patients. 76% were male, the mean length of follow-up was 3.02 years, mean BMI was 28.65, and mean age was 52.10 years. Three of 3,400 cases presented with a pseudotumour, an incidence of .09%.

**Conclusion:** Although pseudotumors remain a concern after metal on metal hip resurfacing, the incidence at short to mid term follow-up is very low in this multi-centre academic survey. This information is significantly lower than what other groups have recently reported. Continued close monitoring is required in order to determine what clinical factors are at play.

**73 - Cobalt and Chromium Ions Have No Detrimental Effect on Semen Parameters in Young Patients with Metal-on-Metal Total Hip Replacement**

John Antoniou, QC; Alain Petit, QC; Vassilios S Nikolaou, ON; Constantin Papanastasiou*, QC; Jackson Mwale, QC; David J Zukor, QC; Olga L Huk, QC;

**Purpose:** Several studies have shown elevated levels of metal ions in blood of patients with metal-on-metal (MM) total hip arthroplasty (THA). The outstanding question that remains is the clinical impact of these elevated ion levels. Even though it is well known that exposure to heavy metals such as lead, copper, mercury, nickel, and cadmium) may lead to significant alterations in human sperm morphology and motility, less is known on the effect of Co and Cr on semen parameters. The aim of the present study was to investigate the effect of metal ions on the semen of males of child fathering age with MM hip arthroplasty.

**Method:** Semen was collected from 10 patients between 41 and 49 years old (mean = 45±6 years) by masturbation after 2-3 days of abstinence. Samples were examined within 1h after ejaculation for morphology, motility, and number of sperm cells following standard criteria from the World Health Organization (WHO). Co and Cr concentrations were measured in both the seminal plasma and in the blood of patients by inductively coupled plasma-mass spectroscopy (ICP-MS). Since spermatozoa membrane polyunsaturated fatty acids are vulnerable to attack by reactive oxygen species (leading to peroxide formation), peroxide concentrations were measured in both the seminal plasma and the blood of patients.

**Results:** Results showed that the concentration of both Co and Cr ions was significantly lower in the seminal plasma than in the blood of the patients. Results also showed that the levels of peroxides were lower in the seminal plasma than in the blood plasma of these patients. Importantly, the ejaculate volume, the sperm density, the total sperm count, the pH, and the percentage of cells with normal morphology were in the range of the WHO criteria for fertile population and also in the range of reference patients in the city of measurements. However, the viability was a little bit lower than what was observed in a fertile population without prosthesis.

**Conclusion:** The presence of Co and Cr ions in the blood of males of child fathering age with MM hip arthroplasty raised concerns about the quality of semen in these patients. Results of the present study strongly suggest that the raised of Co and Cr had no significant effect on sperm parameters of young patients with MM prosthesis. The methods used to identify potential normal and fertile semen samples are still contradictory and not exactly defined. Studies showed for example that only total numbers of sperm with progressive mobility are significantly different in the fertile than in sub-fertile men, while others suggested that the fertile population should be defined by sperm concentration or sperm morphology. In conclusion, results suggest that Co and Cr ions generated from MM prosthesis have no significant effect on the sperm parameters of young patients of child fathering age. Further longitudinal studies are however necessary to conclusively determine the effect of metal ions from MM prosthesis on sperm parameters.

**74 - RSA Wear Analysis of Oxinium & CoCr Heads Against XLPE and Conventional Polyethylene in THR: A Randomised Controlled Trial**
**Purpose:** Efforts to decrease polyethylene wear have lead to advances in polyethylene and counter-face technology for total hip replacement. In particular, the use of highly cross-linked polyethylene (XLPE) and more recently, oxidized zirconium (Oxinium) heads, have demonstrated significant in-vitro improvements in THR wear. This study reports on the early clinical performance and wear (measured with RSA) of an randomized controlled trial (RCT) comparing Oxinium and CoCr heads on XLPE and conventional polyethylene (CPE).

**Method:** Forty patients were enrolled in a RCT and stratified to receive either an Oxinium (Ox) or CoCr head against either XLPE or CPE (ie 10 patients in each group). All patients had otherwise identical THRAs and had tantalum beads inserted in the pelvis and polyethylene for wear analysis. There were no significant differences between groups with respect to patient demographics and the average age was 68 years (range 57-76) at index procedure. RSA wear analysis was performed immediately post-op, at six weeks, three and six months and then at one and two years. All patients are a minimum of four years post-op (average 4.6, range 4 – 5.8).

Patients were followed prospectively using validated clinical outcome scores (WOMAC, SFI-12, Harris Hip scores) and radiographs.

**Results:** All health-related outcomes were significantly improved from pre-operative with a mean Harris Hip score and WOMAC at last follow-up of 90.9 and 80.2, respectively. Total 3D femoral head penetration at two years for each group were the following: CoCrXLPE (0.068±0.029mm); OxXLPE (0.115±0.038mm); CoCrCPE (0.187±0.079mm); and OxCPE (0.242±0.088mm). Thus, OxCPE was significantly higher than OxXLPE and CoCrXLPE but not CoCrCPE (p=0.001, p>0.0001 and p=0.094, respectively). In other words, penetration was higher with CPE compared to XLPE but there was no significant difference between Ox and CoCr heads.

Similarly, regardless of head type (ie combining similar poly types), there was a significant difference in 3D head penetration at two years between CPE and XLPE ( CPE 0.213±0.086; XLPE 0.093±0.041, p<0.0001).

**Conclusion:** The early results of this RCT, using RSA as the wear analysis tool, indicate a significant improvement in wear with XLPE compared to CPE. However, it failed to show a clear advantage to the use of Oxinium over CoCr against either polyethylene. Longer follow-up is required to determine steady-state wear rates (after bedding-in) and allow comparison between bearing groups.

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**75 - The Migration Pattern of a Cementless, Tapered, Plasma Sprayed Femoral Stem Using EBRA-FCA**

**Craig White, UK; Sasha Carsen, ON; Kevin Rasul, ON; Steve Doucette, ON; Paul E Beaulé, ON;**

**Purpose:** We aimed to measure the early migration pattern of a titanium alloy, tapered, plasma and hydroxyapatite coated femoral stem and any factors associated with subsidence.

**Method:** Between January 2005-June 2007, 387 Accolade cementless femoral stems (Stryker, Allendale NJ) were implanted at our institution. Seventy-seven had a minimum of two years post operative follow up and a complete set of pre and postoperative radiographs for analysis. Our group included 45 females with a mean age of 71.4 years, and 32 males with a mean age of 68.5 years. The primary diagnosis was degenerative osteoarthritis in 71 patients, avascular necrosis in two, and post fracture in four patients. The average BMI was 27.1. We measured the canal index to assess bone quality and the canal calcar index to assess the proximal femoral morphology. Immediate postoperative radiographs were assessed for canal fill of the prosthesis and implantation varus/valgus angles. The EBRA-FCA software was used to obtain migration curves for each stem. Best fit curve of subsidence over time was calculated and the data was analysed using a Kaplan Meier survivorship with 1.5 mm of subsidence as an endpoint. We then performed a multivariate and univariate regression analysis for predictors of subsidence.

**Results:** The mean follow up was 29.3months (24-48). The mean canal index was 0.55 (0.36-0.68) with a mean canal calcar index of 0.54 (0.39-0.79). The average canal fill index at the midpoint of the stem was 80 in 40 stems. A total of 414 radiographs were analysed for the EBRA measurements. Of these 21 (5%) were discarded by the software as they did not meet the criteria for comparability. This led to the exclusion of seven patients, leaving the final study group of 77. All remaining patients had a minimum of four radiographs with an average of 4.6 for analysis. The average subsidence at 24 months was 2 mm and this had risen to 2.4 mm by 36 months postoperatively. When analysed using a Kaplan Meier curve using 1.5 mm as an end point we found a survivorship of 63.4% (52.3-74.5) at 24 months and this had worsened to 41.6% (26.6-56.5) by 36 months. Multivariate and univariate regression analysis of measured variables did not reveal any significant hazard for any factor other than the larger stem sizes doing worse.

**Conclusion:** Although several cementless tapered stem designs have had an excellent track record, our migration analysis of the Accolade stem is somewhat concerning. Thirty three percent of stems had reached the 1.5 mm subsidence point by two years. This is of concern as work has previously shown this to predict failure of stems with aseptic loosening at ten years with an accuracy of 79%. If these stems go on to fail at the predicted rate this would represent an unacceptably high level of failure. Our data raises serious concerns about the overall clinical performance of this stem design due to poor initial stability and integration.

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**76 - Greater than 20-year Follow-up Study of the Cementless Porous Coated Anatomic (PCA) Total Hip Arthroplasty**

**Jonathan Loughead, ON; Philip A O’Connor, ON; Kory D Charron, ON; Cecil H Rorabeck, ON; Robert B Bourne, ON;**

**Purpose:** The purpose of this study was to determine the greater than 20 year survivorship of the PCA total hip arthroplasty (THA) in patients with severe hip osteoarthritis.

**Method:** A prospective follow-up of 315 consecutive patients treated with a PCA cementless THA in patients with hip osteoarthritis was performed. Patients had postoperative assessments and radiographs every two years. Overall THA, femoral stem and acetabular cup revisions and Kaplan-Meier survivorship was determined. Revision rates and survivorship was also investigated across gender.
Results: The mean age of our patients was 61 years old (range 20 to 86) with 47% female patients. 226 cases used a 26mm articulation and 89 cases a 32mm articulation. At 23 years follow-up, 188(60%) patients were alive with retained implants while 88(27%) were deceased with still implants that were functioning well. Forty-two cases (13%) were revised (30 sockets, 13 stems), five of which later deceased. The 20 year Kaplan Meier survivorship for the overall THA, stem component and acetabular cup were 86%, 97%, and 90% respectively. Survivorship of the acetabular cup for 26mm and 32mm articulations was 92% and 85% respectively (p=0.016). Females had a worse THA survivorship than males, 82% and 91% respectively (p=0.036).

Conclusion: The PCA cementless THA has performed well beyond 20 years with 26 mm articulations doing better than 32 mm, and male gender associated with better outcomes. The authors postulate that polyethylene thickness is key to predicting failure.

77 - Ceramic-on-Metal versus Metal-on-Metal – Clinical and Metal Ion Results of a Prospective Multicentre IDE RCT
Steven JM MacDonald, ON; Charles A Engh Jr., US; Douglas D Naudie, ON; Charles A Engh Sr., ON; Richard W McCalden, ON; Abigail E Thompson, ON; Supatra Sritulanondha, ON;

Purpose: A ceramic head coupled to a metal liner is a proposed new alternate bearing in THA. The authors participated in an FDA approved multicentre prospective, randomized, blinded clinical trial comparing ceramic-on-metal (CoM) to metal-on-metal (MoM) in patients receiving a THA.

Method: 390 patients received the same acetabular component and metal insert. 194 patients received a delta ceramic head (CoM) and 196 received a metal head (MoM). Metal ions were evaluated in 72 patients (36-CoM, 36-MoM). Harris Hip scores, radiographs, and metal ion levels (cobalt, chromium and titanium in serum, erythrocytes and urine) were evaluated pre-operatively and at three, 12 and 24 months.

Results: No patients were lost to follow-up. There were no differences between groups’ baseline demographics and clinical scores. At two years there were no differences in Harris Hip scores, radiographs, adverse events or postoperative complications. Both groups had overall very low median metal ion profiles with no statistically significant differences. 24 month MoM vs CoM; Serum cobalt (μg/L), mean: 1.2(+/-0.5) vs 1.1(+/-0.3), median: 0.66(range: 0.2-5.6) vs 1.0 (range: 0.3-2.7); Serum chromium (μg/L), mean: 1.1(+/-0.5) vs 1.4(+/-0.4), median: 0.86(range: 0.3-6.9) vs 1.2(range: 0.3-4.9). Urine cobalt and urine chromium (μg/day) demonstrated similar trends to serum ion levels.

Conclusion: While CoM is a new bearing surface in North America and not currently FDA or HPB approved, it has been in clinical use globally since 2006. Results of this non-inferiority RCT demonstrated no clinical outcome, metal ion, radiographic or adverse event differences between CoM and MoM cohorts.

78 - Lateral Femoral Cutaneous Nerve (LFCN) Neuropraxia After Anterior Approach Total Hip Arthroplasty
Krista Goulding, ON; Paul E Beaulê, ON;

Purpose: LFCN neuropraxia is a known complication of the anterior approach to the hip joint. The objective of this study was to define the incidence, functional impact and natural history of this neuropraxia in the anterior approach after both hip resurfacing (HR) and primary total hip arthroplasty (THA).

Method: Between September 2006 and January 2008, 132 consecutive patients underwent a direct anterior hip approach (DAA) (55 THR; 77 HR). Sixty-two patients were female and 70 were male; the mean age was 55.54 (range, 29.9 to 88.7). Self reported questionnaires for sensory deficits of LFCN, a neuropathic pain score (DN4) as well as SF-12, UCLA and WOMAC scores were completed. A subset of 60 patients (30 THA, 30 resurfacing) was evaluated at two time intervals (6 and 12 months).

Results: One hundred and seven patients (81%) reported LFCN neuropraxia, with a mean severity score of 2.32/10 (SD, 2.11); mean DN4 score of 2.42/10 (SD, 2.37). Hip resurfacing had a higher incidence of neuropraxia compared to THA: 91% versus 67% (p=0.02), respectively. No functional limitations were reported on SF-12, WOMAC or UCLA scores. Of the subset of 60 patients, 53 (88.3%) reported neuropraxia at the six month follow-up interval with only three (5.7%) having complete resolution at 12 months. Patients who reported neuropraxia at both testing intervals did report an improvement in DN4 scores: 3.6 versus 2.5 at 6 and 12 months, respectively (p=0.02).

Conclusion: Although LFCN neuropraxia is a frequent complication after DAA total hip arthroplasty, it does not lead to any functional limitations. A decrease in symptoms does occur over time, with only a small number of patients reporting complete resolution.

79 - Long-term Outcome in Modern Hip Resurfacing Arthroplasty; A Minimum of 10 Years Follow-up
Kemi Alo, UK; Peter M Lewis, UK; Jagannath Chakravarthy, UK; Eric S Isbister*, UK;

Purpose: The modern generation of hip resurfacing arthroplasties was developed in the early 1990’s with one of the original designs being the McMinn Resurfacing Total Hip System. This was a hybrid metal on metal prosthesis, with a smooth hydroxyapatite coated press fit mono block cobalt chrome shell with a cemented femoral component. Although no longer produced in this form, lessons may be learned from this original series of components. With metal on metal resurfacing arthroplasty now facing criticisms and concerns with regard function, bone preservation capability and soft tissue issues such as ‘pseudotumors’, it is the aim of this long-term study to assess the outcome and survival of an original series of resurfacing arthroplasties.

Method: 27 resurfacing arthroplasties were performed in 25 consecutive patients between June 1994 and November 1996. 16 right hips and 11 left were performed in 14 female patients and 11 male patients. The average age at the time of surgery was 50.5 years (SD 7.9, range 30-63). All surgeries were performed by a single surgeon using a posterior lateral approach. Following the initial early care,
each patient received bi-annual follow up along with open access to the clinic with any concerns or complications. A retrospective review of the case notes was conducted and outcome scores retrieved from a prospectively updated database. Radiographs were analyzed and a Kaplan Meier survival chart was constructed for the group.

**Results:** At latest review 3 patients have died (5yrs, 8yrs and 13.8yrs) and 1 patient has been lost to follow up (5yrs). 7 resurfacings have required revision, all due to acetabular loosening, at a mean follow up of 7 years 11months (SD 2.03years, range 4-10). Metallosis was documented in 4 of the revision cases, however no extensive soft tissue inflammation or ‘pseudotumor’ identified. The mean follow up of the remaining 16 hips is 12years and 10months (SD 12.8months, Range 10.4yrs-14.0 years). The Kaplan Meier survival at a minimum follow up of 10 years is 75.8% (95% CI 0.67-0.95). Mean Oxford hip scores at latest follow up was 20.6 (SD 8.8, range 12-38). There was no significant difference between cup inclination angles for the surviving cohort and those who required a revision procedure with mean cup inclinations of 52.5 (SD 5.5, range 45-60) and 58 degrees respectively (SD 9.1, range 50-70)(p=0.255).

**Conclusion:** This original series of hip resurfacings, with up to 14 years follow up, shows a survival of 76% at the minimum follow up of 10 years. All failures were due to loosening of the smooth backed acetabulum, which with a modern porous coating, failure may have been avoided or delayed. Despite high inclinations angles no soft tissue reactions were identified within this series. No femoral failures were identified suggesting unlike much literature focus, long-term failure may not be related to the femoral head or neck.

**Paper Session #10 COA Upper Extremity Shoulder**

**80 - Postoperative Rehabilitation after Rotator Cuff Repair: a Web-based Survey of Arthroscopy and Sports Medicine Society Members**

R. Cole Beavis, SK; Alexander I Glogau, US;

**Purpose:** Little evidence exists to guide rehabilitation following arthroscopic rotator cuff repair (ARCR). It is unclear how new repair techniques may affect postoperative protocols. Our purpose was to determine current practices of members of the Arthroscopy Association of North America (AANA) and the American Orthopaedic Society for Sports Medicine (AOSSM.) Our hypothesis was that wide variation would exist in the postoperative rehabilitation following ARCR and that accelerated protocols would commonly be prescribed after double row ARCR.

**Method:** A 28 question web-based survey was sent to all active members of AANA and AOSSM via email addresses listed in the specialty society directory. Non-responders were reminded by 2 additional invitations. Results were tabulated and responses reported as a percentage of respondents.

**Results:** The response rate was 37.7% (797/2112). Most commonly, respondents use a post-operative abduction sling (56.2%) and begin physical therapy within the first 2 weeks (42.1%). Passive ROM is initiated within 2 weeks (74.1%), active ROM after 6 weeks (55.3%) and strengthening after 6 weeks (64.4%). Unrestricted activities are permitted at 5 months (41.2%). 85.2% of respondents alter rehabilitation based upon tear size. Protocols were altered based upon tissue quality (86.9%), involvement of subscapularis (68.7%) or biceps tendon (65.2%) but not for workers compensation status (97.1%), smoking (71.5%) or patient age (70.3%). 81.1% had performed double row rotator cuff repairs; however 95.2% of those do not alter their postoperative protocol based upon repair configuration.

**Conclusion:** Our results demonstrate wide variation among respondents with regards to immobilization, ROM and return to activity. The majority had performed double row ARCR, however 95.2% of these do not alter their postoperative rehabilitation in patients undergoing double row repair.

**81 - Emotional and Physical Aspects of Disability in Patients with Rotator Cuff Pathology: A Comparison Between Full-thickness Tears and Impingement Syndrome**

Helen Razmjou, ON; George Athwal, ON; Richard Holtby, ON;

**Purpose:** The purpose of this study was to investigate the difference in the level of pre and 6 months post operative objective and subjective measures of disability between patients with full-thickness rotator cuff tears and those with impingement syndrome/partial thickness rotator cuff tears.

**Method:** This study involved a review of prospectively collected data from a consecutive series of patients who had undergone surgery related to rotator cuff pathology (acromioplasty with or without resection of clavicle for impingement syndrome/partial thickness rotator cuff tears or repair for full-thickness rotator cuff tears). Exclusion criteria included previous surgery, concomitant pathologies, and work-related injuries with an active compensation claim related to the shoulder. Standardized pre and post-operative data (history and clinical examination, including strength assessment) were collected. To measure symptoms and functional levels, all patients completed a disease-specific outcome measure, the Western Ontario Rotator Cuff (WORC) Index which explores five domains of physical symptoms, life style, work, sports, and emotions. Paired and independent non-parametric (Wilcoxon two sample tests, and Wilcoxon signed rank tests) statistics were used where normality of data were violated.

**Results:** Three hundred and five patients (130 women and 175 men) with a mean age of 58 years (range, 21-82) met inclusion criteria. One hundred and ninety eight (65%) patients had full-thickness rotator cuff tears and 107(35%) had impingement [59 (55%)] or partial thickness rotator cuff tears [48 (45%)]. Patients with full-thickness tears complained of greater weakness, had a higher prevalence of a specific injury such as fall on an outstretched hand, and reported a higher frequency of insidious onset of pain. The full-thickness tear
group was significantly weaker in elevation both pre and post-operatively. Patients with impingement syndrome expressed more severe symptoms and more emotional disability prior to surgery and had more physical disability related to lifting and performing activities of daily living and more emotional disability 6 months after surgery. Both groups showed a statistically significant improvement in overall pain, WORC score, and strength 6 months following surgery.

Conclusion: Our results indicate that the extent of rotator cuff pathology and level of physical and emotional disability do not necessarily correlate positively in the early phase of recovery. Patients with less severe rotator cuff pathology tend to be more disabled both before and after surgery. This needs to be considered when planning for return to work and other activities and when assessing treatment outcomes.

82 - Arthroscopic "Hill-Sachs remplissage": Capsulotenodesis Healing and Range of Motion in 29 Patients at Short-term Follow-up
Jason Old, MB; Pascal Boileau, FR; Miguel Pinedo, CL; Pablo Vargas, CL; Matthias Zumstein, CH;

Purpose: The "Hill-Sachs Remplissage" (HSR) is a procedure used in the treatment of anterior shoulder instability associated with an engaging Hill-Sachs (HS) defect. It consists of an arthroscopic capsulotenodesis of the posterior capsule and infraspinatus tendon within the defect. There is currently no evidence that the capsule and tendon heal in the humeral bone defect. Our hypotheses were 1) that the capsulotenodesis heals in the HS defect and fills at least 50% of its area; and, 2) that limitation of range of motion compared to the non-operated shoulder would be minimal.

Method: Prospective clinical study. Inclusion criteria: 1) recurrent anterior shoulder instability; 2) engaging HS lesion. Exclusion criteria: 1) glenoid bone loss; 2) rotator cuff tear. Twenty-nine patients underwent an arthroscopic Bankart repair plus HSR. Clinical assessment at a mean follow up of 13.1 months (range 6 to 32 months) consisted of a structured interview and detailed physical examination including range of motion compare to the contralateral shoulder and instability signs. Range of motion was analyzed in two groups according to length of follow-up. Group 1 with less than 12 months follow-up (14 patients); and Group 2 with greater than 12 months follow-up (15 patients). Either a CT arthrogram (25 patients) or an Arthro-MRI (2 patient) was performed at a minimum of six months postoperatively. Four orthopaedic surgeons analyzed the images independently to determine the percentage of healing of the capsulotenodesis.

Results: There was no recurrence of instability at the latest follow-up. There was no statistically significant deficit in forward elevation in either group. Group 1 patients had statistically significant mean deficits as compared to the contralateral side of 15 degrees of external rotation in adduction (ER1), 15 degrees of external rotation at 90 degrees of abduction (ER2), and 1.1 points of internal rotation in adduction according to the Constant score system (ER1). Group 2 patients had statistically significant mean deficits of 4 degrees of ER1 and 11 degrees of ER2, with no significant difference in IR1. There was healing of the capsulotenodesis within the bone defect in all twenty-seven patients. The bone defect was filled more than 75% of its surface in 22 of 29 patients (76%). The remaining seven had between 50 and 75% filling (24%). There was no defect filling of less than 50% in this study.

Conclusion: We demonstrated greater than 50% HS defect filling in all patients in our series after an arthroscopic "Hill-Sachs Remplissage" and filling >75% in 22 of 29 (76%). Modest deficits of external rotation were demonstrated at greater than 12 months follow-up. While these results suggest that the technical goal of HS defect filling is achievable, longer term studies are necessary to establish whether there is an association between the rate of healing, the functional impairment of external rotation and clinical outcomes.

83 - Clinical Outcome of Arthroscopic Debridement of Low-grade Partial Tears of Long Head of Biceps Tendon: A Matched Cohort Study
Richard M Holtby, ON.; Helen Razmjou, ON; Gregory Stranges, MB;

Purpose: The purpose of this matched cohort study was to examine the clinical outcome of biceps tendon debridement at two years following surgery.

Method: The study group included patients who had undergone debridement of a tear of less than or equal to 50% of the biceps tendon. The control group did not have biceps pathology and was chosen from the same pool of data and was matched with the study group by sex, age and type of associated pathology. Standardized pre and post operative data on history and clinical examination of all patients had been collected prospectively. The outcome measures were the American Shoulder and Elbow Surgeons (ASES) assessment form, the relative Constant-Murley score (CMS), and the Western Ontario Rotator Cuff (WORC) Index. Paired and independent T-tests were performed.

Results: Review of data identified 122 patients (16 females, 45 males in each group). The mean age was 59 (SD: 11) and 57 (SD: 12) for the study and control groups respectively. Fifty six percent of the subjects in each group (34/61) had impingement or partial thickness rotator cuff tears treated with a decompression (acromioplasty/decompression). Twenty two patients (36%) had rotator cuff repair, and 5 (8%) had a SLAP repair. A statistically significant improvement was observed in the scores of WORC, ASES and CMS (p<0.0001) in both groups. The magnitude of change, based on the effect size showed a large change in both groups. There was no statistically significant difference in pre and post-operative scores or recovery between groups.

Conclusion: Low grade tears of the biceps tendon do not appear to produce more disability prior to surgical treatment and are effectively treated with biceps debridement in addition to surgical treatment of associated pathologies.
84 - Arthroscopic Treatment of Shoulder Stiffness: Results According to Etiology in 30 Patients
Ryan T Bicknell, ON; Matthieu César, FR; Elyès Fourati, FR; Virginie Rampal, FR; Pascal Boileau, FR;

**Purpose:** The objective of this study was to analyze the clinical results of arthroscopic release for the treatment of shoulder stiffness and to report the results according to etiology.

**Method:** Thirty cases were reviewed in 29 patients with a mean age of 48 years [range, 25-75]. The mean time from diagnosis to surgery was 37.5 months [range, 6–120]. The stiffness was considered idiopathic (i.e. frozen shoulder) (10 cases), post-traumatic (eight cases) or post-surgical (12 cases). The release consisted of 14 rotator interval resections, four anterior capsulotomies, 20 anterior and inferior capsulotomies, three tenotomies of the superior portion of the subscapularis, and 11 biceps tenotomies or tenodeses. In 26 cases, associated extra-articular procedures were also performed, including 22 subacromial bursectomies and four acromioplasties. Patients were reviewed at a mean follow-up of 44 months [range, 12-99].

**Results:** Eighty-nine percent were satisfied or very satisfied. The mean Subjective Shoulder Value was 76%. The mean Constant score increased from 40 ± 13 points preoperatively to 74 ± 16 points postoperatively (p< 0.05).

**Conclusion:** Conclusions: Arthroscopic shoulder release is effective for pain relief and improved function. The recovery of motion is better in idiopathic stiffness (i.e. frozen shoulder) than in post-traumatic and post-surgical stiffness. Resection of the rotator interval seems effective to restore external rotation and elevation.

85 - The Risk of Poor Functional Outcome Following Rotator Cuff Surgery, Based on Preoperative Pain Scores
Chris B Chant, ON; Joy MacDermid, ON; Darren S Drozdowech, ON; Kenneth J Faber, ON; George Athwal, ON;

**Purpose:** The purpose of this study was to identify if preoperative pain scores predict postoperative pain and functional outcomes in patients following rotator cuff surgery and if a threshold where increased risk occurs could be established. Establishing a risk threshold may help identify patients who need increased follow-up or rehabilitation.

**Method:** One hundred six subjects with rotator cuff pathology requiring operative intervention were prospectively followed. The pain subscale of the Shoulder Pain and Disability Index (SPADI) was used as an indicator of pre-operative pain. Postoperative function one year following surgery was determined using the Simple Shoulder Test (SST). Scores with 40% or more deficit (compared to age matched controls) were classified as poor outcomes. The relative risk (RR) of poor SST scores was calculated across different cutoffs for preoperative pain scores.

**Results:** Having a high preoperative pain score was associated with a poor outcome following rotator cuff surgery at both the six month and one year followup. Preoperative pain scores did predict postoperative functional scores. As preoperative pain levels increased there was a higher risk of poor functional outcomes. The RR of having a poor SST at 1-year was 2.3, if preoperative pain score was greater than 35/50.

**Conclusion:** The current study indicates that those patients with high preoperative pain scores (>35/50 or >70%) are more than twice as likely to have a poor outcome following rotator cuff surgery. This should inform patients and surgeons for postoperative expectations. Whether closer follow-up, pre-rehabilitation, more intensive postoperative rehabilitation or enhanced pain management can alter this prognosis warrants investigation.

86 - Osteolysis and Complications Following the Use of the Interference Bioabsorbable Screw for Distal Biceps Tendon Repair
Dominique M Rouleau, QC; Sylvain Gagnon, QC; Anna Potapov, QC; Fanny Canet, QC; G. Yves Laflamme, QC;

**Purpose:** Anatomic repair of an acute distal biceps tear has been demonstrated to improve flexion and supination strength compared with conservative treatment. The most commonly used fixation methods for a distal biceps tendon repair include suture anchors, bioabsorbable screws, and endobutton. The goal of this study was to 1) perform a radiologic evaluation of bioabsorbable screw tunnel osteolysis and 2) retrospectively review bioabsorbable-screw related clinical complications.

**Method:** We included twenty (20) consecutive patients who underwent primary anatomic repair of the distal biceps tendon since 2005. We used a 7x23mm biotenodesis® screw (Arthrex) in 18 cases, and 8x23mm and 8x12mm screws in the other two cases. First, from the x-ray view done in the immediate postoperative period showing the complete screw tunnel, we measured the ratio of the volume of the bone tunnel to the volume of the radius bone section. A mathematical formula for cylindrical volume was used (¶ x r2 x h). We used a relation between two volumes rather than the tunnel volume itself for scaling purposes. Secondly, we calculated the same relation on the x-ray from the last follow-up. We then obtained the percentage of tunnel enlargement by relating the volumetric ratio from the first x-ray to the ratio from the last x-ray. Afterwards, we performed a retrospective chart review noting any bioabsorbable screw-related and postoperative complications.

**Results:** In the group, the average age was forty-six (46) years. All subjects were male. Eighteen (18) cases were acute complete ruptures operated in the first three weeks, one case was a partial rupture and one case was chronic (one year). The average follow up was eighteen (18) months. We found that the average initial relative volume occupied by the screw tunnel was 47 % of the bone section. At the last follow-up, this volume increased to 68%. After our chart review, we found that one patient presented with a broken screw and increased pain and that another patient developed a severe foreign-body reaction with re-rupture of the tendon requiring three reoperations.
Conclusion: The use of a bioabsorbable screw for distal biceps tendon fixation results in significant osteolysis of the radial bone at short term follow-up. Consequences of osteolysis in the radius are worrisome since iatrogenic fractures are more likely to occur. Osteolysis can be secondary to an inflammatory reaction to the screw material, bone necrosis secondary to pressure or initial thermal necrosis. We also noted two cases of severe biotenodesis screw-related complications among our series of twenty (20) patients. These results call into question the use of the bioabsorbable screw in distal biceps tendon repair and are important to present. Exact volume of bone loss using 3D computed tomography scan analysis as well as quality of life questionnaires and strength testing will be available for presentation.

87 - Hydrodilatation in the Frozen Shoulder
Zafar Iqbal Ahmad, UK; Chris Ingham, UK; Chris Roberts, UK;

Purpose: Frozen shoulder, an excruciatingly painful condition known medically as adhesive capsulitis, affects two million people in Britain. Diabetics and women aged 40-60 are particularly at risk. The current treatment for frozen shoulder includes painkillers, physiotherapy, or surgery. The above presents their own problems, including recurrence of symptoms, failure of therapy, and for surgery: recovery period, anaesthetic and surgical operative risks. In contrast, the therapy involving hydrodilatation injections into the shoulder takes just ten minutes and allows patients to go home immediately. Hydrodilatation had fallen out of favour as a means of treating frozen shoulders until the recent publications specifically the King’s Lynn study (Quraishi et al) in 2007. Our objective is to see if we can reproduce these results that the King’s Lynn study shows.

Method: Our study is a cohort study, prospectively evaluating the outcome of hydrodilatation as treatments for adhesive capsulitis. 24 patients were treated with hydrodilatation, and had Oxford scores done before injection; 2 months and 6 months after injection. The overall scores were recorded as was the range of movement.

Results: The overall scores for the study showed a significant improvement and increased ROM of patients’ shoulders.

Conclusion: We believe our study shows that hydrodilatation is an effective means of treating frozen shoulders. We believe our study demonstrates the need for hydrodilatation to be more widely practiced. Other therapy such as painkillers and physiotherapy has shown not to be effective, and surgery has its respective complications. Therefore, hydrodilatation offers a minimally invasive, cheap, low risk alternative.

88 - Predicting Patient Outcome of Non-operative Treatment for a Chronic Rotator Cuff Tear
Kristie D More, AB; Richard S Boorman, AB; Dianne Bryant, ON; Nicholas GH Mohtadi, AB; Preston Wiley, AB; Kelly Brett, AB;

Purpose: A major issue in the Canadian health care system are the extensive wait times for consultation with an orthopaedic surgeon. We identified that a high percentage of patients referred to shoulder surgery sub-specialists for chronic full thickness rotator cuff tears had not undergone appropriate non-operative treatment prior to being referred, and ultimately did not require surgery. In an effort to improve the referral process and to optimize patient care, we sought to identify clinical predictors for outcome of non-operative treatment of chronic full-thickness rotator cuff tears. This would allow general practitioners to clearly identify patients who are most likely to fail non-operative treatment and actually require surgical consultation. The primary purpose of this study was to determine if the outcome of non-operative treatment in chronic, symptomatic, full-thickness rotator cuff tears could be predicted based upon presenting clinical characteristics, including: age, dominant extremity involvement, gender, duration of symptoms, onset (acute or chronic), forward elevation range of motion, external rotation strength, size of tear, smoking status, and the Rotator Cuff Quality of Life Questionnaire score (RCQOL).

Method: Fifty patients, between the ages of 40 and 85 years, with a documented full-thickness tear on ultrasound or magnetic resonance imaging (MRI), were recruited prospectively. They underwent a three month home-based program of non-operative treatment under the supervision of an experienced physiotherapist and sport medicine physician. At the conclusion of the three month program, patients were evaluated by an orthopaedic surgeon and were defined as having been successful or as having failed non- operative treatment. Successful patients declined surgical treatment after consulting with the surgeon, whereas failed patients elected to undergo surgery, or, if avoiding surgery for other health or “life” reasons, had not experienced adequate improvement with the non-operative program to have been considered successful. The patient’s baseline clinical characteristics were analyzed using logistic regression to determine which characteristics were predictive of outcome.

Results: Thirty-eight of 50 (76%) of patients were successful with the non-operative program. Univariate analysis showed that a patient’s Rotator Cuff Quality of Life questionnaire score was a significant predictor of outcome of non-operative treatment (p = 0.017). Patients who were successful with non-operative treatment had a mean baseline RCQOL score of 49/100, whereas patients who failed non-operative treatment had a mean baseline RCQOL score of 31/100. The two factors of patient age and dominant extremity involvement also trended toward significance.

Conclusion: Baseline RCQOL score can predict which patients will be successful with non-operative treatment and which patients will fail non-operative treatment for a chronic, full-thickness rotator cuff tear.

89 - Glenoid Version: How to Measure it? Reliability, Consistency and Inter-observer Agreement of Different Methods in 2D CT-scan
Dominique M Rouleau, QC; Jake Kidder, US; Juan Pons de Villanueva, ES; Savvas Dynamidis, IT; Michael De Franco, US; Gilles Walch, FR;
Purpose: Recognition of the glenoid version is important for evaluation of different pathologies. There is no consensus on method to use to evaluate version. The purpose of this study was to compare different measurement strategies in one hundred-sixteen (116) patients with shoulder CT-scans.

Method: Scapula CT-scan axial images were revised and the cut below the base of the coracoid was selected. The glenoid version was measured according to the Friedman method (FM) and the “scapula body” methods (BM). In case of B2 glenoid three different reference lines have been measure: the neo-glenoid NG (posterior erosion surface), paleo-glenoid PG (original glenoid surface) and the intermediate-glenoid IG (line from anterior and posterior edge). Three orthopaedic surgeons independently examined the images two times and intra/inter-observer reliability was calculated using Intra-Class Correlation (ICC). The objective of this paper is to define which method shows best reliability.

Results: Group 1 (B2 excluded n=53): The average glenoid version was significantly different between two measurement techniques for all three observers, with an average of -7.29° for BM technique and -10.43° for FM. Intra-observer reliability was excellent for both methods (ICC= 0.958-0.979 for FM; 0.940-0.970 for BM). Inter-observer reliability was excellent for both methods (FM: ICC= 0.977; BM: ICC= 0.962). The light superiority of the first method was not significant. For group 2 - B2 glenoid (n=63): six different measures of version were taken resulting by two scapula reference line (FM and BM) and three glenoid reference line (PG, IG, NG). The average glenoid versions were significantly different (p<0.82). The inter-observer reliability were also very good or excellent for all methods (ICC >0.79). The most reliable method for measurement of B2 glenoid version was the association of the Friedman line for the scapula axis and the intermediate glenoid line with excellent intra observer reliability (ICC > 0.957) and inter-observer reliability (ICC=0.954).

Conclusion: Measurement of glenoid version on axial cut of a Ct-scan is highly reliable. Significant differences exist between measures depending which method is used, underlying the importance of a consensus for research and clinical purpose. Despite very good performance of all methods, authors recommend the use of the Friedman method for the scapula axis reference and an intermediate glenoid line in case of B2 glenoid.

Paper Session #9 COA Hand/Wrist/Tumour

90 - Stabilization of Pathologic Humerus Fractures with the Cemented Plate Technique: The Toronto Experience
Kurt R Weiss, ON; Rej Bhumbra, ON; Wazzan Al-Juhani, ON; Anthony Griffin, ON; Benjamin Deheshi, ON; Peter Ferguson, ON; Robert Bell*, ON; Jay S Wunder, ON;

Purpose: Impending and pathologic fractures of the humerus, usually due to metastatic disease, are associated with significant pain, morbidity, loss of function, and diminished quality of life. Several methods of stabilization have been described. Here we report the outcome of fixation using intramedullary poly methyl methacrylate (bone cement) and non-locking plates.

Method: A retrospective review was undertaken which included all patients treated at a tertiary musculoskeletal oncology referral center from February, 1989 to October, 2009. Patients who underwent surgical management of an impending or pathologic fracture of the humerus were included. All patients were treated using the following technique: Vascular tumors were embolized pre-operatively. Following gross tumor removal through curettage, antibiotic bone cement was placed into the humeral canal and bone defect. If there was a fracture, the bone ends were held in place as the cement cure. The humerus was stabilized using non-locking plates fixed with screws inserted through the bone and hardened bone/cement composite. Ideally, plates spanned the osseous defect by at least 2 cortical diameters and often the entire length of the bone.

Results: Clinical records were available for 67 patients who underwent the above procedure. There were 44 males and 23 females with an average age of 62.2 years. In 76% of patients there was a pathologic fracture at presentation, while in 24% it was impending. The most common histology was myeloma (21%), followed by renal (20%) and lung adenocarcinoma (20%). Forty-nine patients (73%) had one plate, 16 (24%) had two plates, one patient had three plates, and one had four plates. Complications occurred in 14 (21%) cases, and eight (12%) required reoperation of the humerus. The most common cause for reoperation was disease progression (six of eight). There were two nerve palsies, one deep infection, and one hardware failure. Interestingly, the single hardware failure occurred in a patient whose pain relief and functional status improved to the point that he fractured his construct while hammering with the affected arm in a home improvement project.

Conclusion: Intralesional tumor resection and stabilization of impending and pathologic fractures of the humerus with the described technique has several attributes. Most importantly, it provides immediate, absolute rigidity of the upper extremity and enables early pain relief and return of function without the need for osseous union. Radiation has no negative effects on the construct. The patient’s local disease burden is reduced, thus helping to alleviate tumor-related pain and slow local disease progression. Finally, this technique is user-friendly and cost-effective as it does not require any special equipment or devices that are not available to community orthopaedic surgeons. This technique provides a durable option for the treatment of impending and pathologic humerus fractures.

91 - Contribution of FPL to Pinch Strength- An in vivo Study
Anthony J Costa, BC; Satyam Patel, SK; Kishore Mulpuri, BC; Andrew Travlos, BC; Thomas J Goetz, BC; Ruth Milner, BC;

Purpose: Pinch strength has been shown to be a predictor of the ability to grip objects and perform functional hand-related tasks. As the sole flexor of the thumb IP joint, the flexor pollicis longus (FPL) muscle has previously been shown to play an essential role in directing thumb tip force as well as contribute to overall pinch strength. The relative contribution of FPL to pinch strength is unknown
However, as the FPL may be affected in several acute and chronic conditions, determining the contribution of FPL to pinch strength may be useful in planning as well as evaluating treatment options. The purpose of this study was to estimate the contribution of FPL to pinch strength in vivo using an EMG-guided, selective motor blockade, test-retest protocol.

**Method:** 11 healthy volunteers were recruited to participate in the study. All participants completed a brief questionnaire regarding prior hand injuries and subsequently underwent a physical examination to assess baseline hand function. Baseline pinch strength was recorded using three different pinch techniques: key pinch, 3-point chuck grasp, and tip pinch. Participants then underwent EMG-guided lidocaine blockade of the FPL muscle. Motor evoked potentials as well as skin potentials were used to confirm adequate FPL blockade. The physical exam was repeated as were pinch strength measurements. Post block splinting was necessary to stabilize the thumb IP joint. Grip strength, in addition to clinical examination, was utilized pre and post block to assess for inadvertent blockade of other muscle groups or nerves. A final clinical evaluation was conducted at study completion to note any complications or adverse effects.

**Results:** All three types of pinch strength showed a significant difference between pre and post measurements (p<0.01). The mean differences pre and post were 9.7N, 6.4N, and 5.2N in key, 3-point chuck, and tip pinch respectively (p<0.01). The relative contribution of FPL for each pinch type was 53.2%, 39.5%, and 44.3%. EMG, motor evoked potentials, and skin potentials confirmed adequate paralysis of the FPL. Physical examination did reveal decreased sensation in median and radial nerve distributions in some individuals, however the effect on observed motor function was negligible. Grip strength decreased by only 4N post blockade confirming no clinically significant median nerve motor blockade. The protocol was well tolerated and no serious complications were noted.

**Conclusion:** Using an in-vivo model we were able to estimate the contribution of FPL to overall pinch strength. In our study, FPL’s contribution to pinch strength was estimated to be 9.7N, 6.4N, and 5.2N in key, 3-point chuck, and tip pinch respectively (p<0.01). The relative contribution of FPL for each pinch type was 53.2%, 39.5%, and 44.3%. Inherent limitations in study design may have tended to overestimate the contribution of FPL to pinch. This information may be useful in planning and evaluating treatments for acute and chronic conditions affecting FPL function.

92 - Does an Ulnar Styloid Fracture Affect Outcome Following Distal Radius Fracture in Adults Less Than 65 Years of Age?
Robert KW Chan, AB, Joy MacDermid, ON; Kayvan Nateghi, ON; Ruby Grewal, ON;

**Purpose:** The purpose of this study was to determine the impact of an ulnar styloid fracture (USF) associated with a nonsurgically or surgically treated distal radius fracture (DRF) in adult patients under 65 years of age.

**Method:** This was a cohort study involving 170 DRF patients aged 18 to 64 years old that presented to a single tertiary care center from 2004 to 2008. At initial presentation, three, six, 12 and 24 months follow up, patients were asked to complete a standardized pain and disability self-report measure, Patient Rated Wrist Evaluation (PRWE). All participants had posterior-anterior and lateral wrist radiographs performed at initial presentation and at each visit. Radiographs were reviewed at initial presentation, post treatment and at final follow up for DRF alignment as well as USF information. USFs were classified by size into tip, middle and base.

**Results:** There were 170 DRF patients with two patients having bilateral injuries giving a total of 172 DRFs. Age ranged from 20 to 64 years old with a mean age of 50. There were 113 females and 57 males. Eighty-four of the DRFs were not associated with an USF and 88 were. Of these 88, 42 were tip, 18 were middle and 28 were base USFs. Thirty-two of these USFs (36%) were united at final follow up. One-hundred and one patients were treated nonoperatively and 69 treated operatively for their DRFs. The PRWE scores of DRF patients with an associated USF of any size were significantly better than those without an associated USF only at 24 months follow up (10 vs. 23, p=0.04). Patients with an USF in the middle or at the base had better PRWE scores at both 12 and 24 months (17 vs. 23, p=0.05 at 12 months & 10 vs. 20, p=0.01 at 24 months). An ulnar head fracture had no influence on PRWE scores. There was no difference in PRWE scores between united and nonunited ulnar styloid fractures at all follow up time points.

**Conclusion:** We found that an USF was associated with better PRWE scores at 24 months and that the larger USFs, middle and base fractures, were associated with better scores as early as 12 months. A fall onto the outstretched hand includes a component of force transmission through the ulnar side of the wrist. Without a bony ulnar styloid injury, we hypothesize that this force is transmitted through the soft tissues, creating an associated occult ligamentous, TFCC or other undetected soft tissue injuries resulting in higher pain and disability among those without a fracture. This hypothesis will require further attention in future studies. Union of the USFs also did not show an effect on outcome.

93 - Investigation into the Natural History and Treatment Outcomes for Kienbock’s Disease
Glynn Martin, NL; Daniel Squire, NL;

**Purpose:** To investigate the natural history and clinical outcomes of patients suffering from various stages of Kienbock’s disease (KD) in the NL population.

**Method:** The present study was a retrospective analysis of 66 patients (42 male and 24 female) diagnosed with KD. Following chart reviews of these patients, a telephone interview was conducted to acquire responses to the DASH questionnaire. All analyses were performed using SPSS for Windows (version 15.0), and significance was set at P10 years). Pearson correlation was used to assess for a correlation between DASH scores and age of diagnosis as well as radiographic stage of disease. Multivariate linear regression analysis was used to account for confounding factors.

**Results:** The average age of diagnosis was 38.8 ±11.6 (18-70), right wrist affected in 61.5% of cases and left in 38.5%. History of trauma was present in 25 cases. With respect to radiographic stage of KD at time of diagnosis, 6 cases were in stage I, 26 in stage II, 9 in stage IIIa, 16 in stage IIIb, 5 in stage IV, and 4 with unknown stage. Forty-eight patients were treated conservatively, while 18 surgically (7 following failed conservative treatment). Thirty-nine patients provided a response to the DASH questionnaire. There was
no statistically significant difference in DASH scores between any of the groups according to time since first diagnosed. There was also no significant difference in DASH scores between surgically treated and conservatively treated patients, regardless of stage of KD. Nor was there any difference in DASH scores among surgical and conservatively treated patients when individual stages of KD were considered. Furthermore, because of low numbers within each KD stage, stage III and stage IV were combined. However, once again no significant difference was found between the surgical and conservative treatment modalities. Interestingly, a positive correlation was found between age of diagnosis and DASH score (r=0.42, p=0.007). Multivariate linear regression analysis showed that the correlations remained significant after accounting for the radiographic stage of KD, gender, and time since diagnosed (p=0.02).

Conclusion: No statistically significant difference in DASH scores were found between surgically treated and conservatively treated patients in the NL population with KD regardless of stage of disease. A positive association was found between age of diagnosis of KD and DASH score, even after accounting for gender, stage of disease, and time since diagnosis. This finding suggests that those patients’ who are diagnosed and treated for KD later in life, tend not to do as well as their younger counterparts.

94 - Preoperative PET-CT is Not Useful for Identifying De-differentiation of Well-differentiated Liposarcomas

Paul W Clarkson, BC; Anna Thompson, ON; Amy E Phillips, BC; Torsten O Nielsen, BC; Don Wilson, BC; Lorna Weir, BC; Rona Cheifetz, BC; Karen Goddard, BC;

Purpose: To determine whether combined modality Positron Emission Tomography and Computed Tomography (PET-CT) imaging can pre-operatively identify de-differentiated areas within well-differentiated liposarcomas/atypical lipomatous neoplasms. Well-differentiated liposarcomas show a reasonably homogeneous lesion with fat signal characteristics on MRI and are managed with surgical excision or regular observation. They can recur locally, but never metastasize. Up to 5% of well-differentiated liposarcomas will contain a de-differentiated component that is not apparent on MRI. When present, this de-differentiated component carries a much worse prognosis and requires more aggressive local management. Currently this is only identified after surgical resection. Pre-operative identification of a de-differentiated component within the lesion by PET-CT would allow for better treatment planning. However, PET-CT is an expensive investigation and has not been reported in this application before, although it has been used for imaging of soft tissue tumours.

Method: We have prospectively enrolled 40 subjects into this study. Eligible subjects presented with a >8cm and deep well-differentiated liposarcoma in the extremities or retroperitoneum, which was confirmed by MRI. Subjects underwent a pre-operative PET-CT scan to look for areas of de-differentiation within the lesion. The PET-CT results were compared to the final pathological analysis of the surgical specimen. When necessary for diagnostic purposes, cytogenetic analysis was also completed.

Results: Thirty-one of the 40 subjects enrolled have had PET-CT scan and surgery. Seven subjects were waiting for PET-CT and surgery by December 2009. Two subjects were withdrawn from the study: one because the PET-CT scan could not be scheduled prior to surgery, and one because the subject ultimately declined surgery. Of the 31 lesions excised, 2 contained de-differentiated areas within the lesion. The PET-CT detected a small area of low to moderate FDG uptake (thigh lesion, max Standard Uptake Value (SUV) 3.6) for one of these patients; however no uptake on PET-CT was seen for the other (retroperitoneal lesion, max SUV 1.7).

Conclusion: PET-CT does not appear to reliably detect de-differentiated areas within well-differentiated liposarcomas. Our data does not support the use of PET-CT for this purpose as it may be misleading and wasteful of resources.

95 - Triangular Fibrocartilage Complex 1b Lesions: Arthroscopic Repair

Francesco Pegreffi, IT; Lorenza Belletti*, IT; Marco Esposito, IT;

Purpose: The purpose of this study was to evaluate the long-term results of arthroscopic treatment in patients affected by triangular fibrocartilage complex (TFCC) type 1b lesions associated with distal radio ulnar joint (DRUJ) instability.

Method: 138 patients affected by TFCC type 1b lesions: Group A (117 patients, 27±7 yrs) were treated using an out-in arthroscopic technique and Group B (21 patients, 24±4 yrs) with an associated total DRUJ instability, were treated using an out-in arthroscopic technique in addition to an anchor placement. Inclusion criteria were: TFCC tears, type 1b lesions and no previous wrist fractures. SF-36, DASH, VAS, and ROM were assessed preoperatively and at four years follow-up.

Results: All the patients have a significant improvement in terms of SF-36 (p<0.05).

Conclusion: Arthroscopy is a tool of paramount importance in both diagnosis and treatment of TFCC injuries even associated with DRUJ. Furthermore, type 1b lesions associated with total DRUJ instability should be managed combining an out-in arthroscopic technique with the use of an anchor to completely relieve pain and restore wrist function.

96 - Outcomes after revision for mechanical failure of the Kotz Modular Femoral Tibial Replacement (KMFTR) prosthesis

Rej Bhumbra, ON; Anthony Griffin, ON; Kurt R Weiss, ON; Wazzan Al-Juhani, ON; Benjamin Deheshi, ON; Jay S Wunder, ON; Peter Ferguson, ON;

Purpose: Massive endoprostheses have become the mainstay of treatment for reconstruction after resection of primary bone tumours. The Kotz Modular Femoral Tibial Replacement (KMFTR, Kotz prosthesis, Stryker Inc.) system has been one of the most widely utilized uncemented modular systems. Although this prosthesis has excellent bone ingrowth characteristics and a low aseptic loosening rate, we have identified a significant incidence of mechanical failure and breakage of the prosthesis. The purpose of this investigation is to review the outcomes after prosthetic revision for a broken Kotz prosthesis.
Method: A retrospective review was undertaken of our institutional database from the years 1989, when we first utilized the Kotz prosthesis, until present. We identified all patients who had undergone a revision of the prosthesis for mechanical failure or prosthetic breakage. Periprosthetic fractures and revisions for polyethylene bushing wear were excluded.

Results: 119 distal femoral, 55 proximal tibial and 47 proximal femoral Kotz endoprostheses (221 in total) have been implanted in our center since 1989. There were 21 revisions (9.5% of total prostheses) for mechanical failure. Of these, 16 were in the distal femur, four in the proximal tibia and one in the proximal femur. Mechanical failures occurred at a mean of 77 months (range 24-170). Of the 21 metal failures, 8 stems broke at the junction of the stem and body, 8 fractured through screw holes in the stem, 3 fractured the derotation lug, one fractured the tibial housing and one lateral side-plate failed. Of these failures only three implants had associated definite loosening and two of these three were cemented. Broken stems initially required extraction whilst preserving as much of the longitudinal and transverse bone stock as possible in order to facilitate osseo-mechanical integration of the revision prosthesis. This was accomplished using trephines to core the ingrown broken stem out of the bone. Over the last 20 years, the 16 broken stems have been revised in 5 patients to larger Kotz uncemented stems, 2 to cemented GMRS stems with an adaptor to the KMFTR system, 3 to Restoration uncemented revision hip stems with a custom adaptor to the KMFTR system, 2 to custom GMRS uncemented stems with an adaptor to the KMFTR system, and 4 to total femurs. All except one patient was alive with no evidence of disease. Post-revision, 14 patients had TESS, MSTS87, MSTS93 scores of 80.5, 25.5 and 70 respectively.

Conclusion: Despite very low aseptic loosening rates, mechanical failure of the Kotz prosthesis continues to be a significant clinical problem even several years after implantation. Fatigue failure often leads to the difficult scenario of removing a well-ingrown uncemented stem. Our data illustrates that these prostheses can often be successfully revised by trephining out the broken stem and inserting new uncemented stems. Functional outcome continues to be good and is comparable to pre-revision levels.

97 - Computer-assistance versus Customized Guides for Distal Radius Osteotomy
David Pichora, ON; Burton Ma, ON; Manuela Kunz, ON; Hisham Alsanawi, ON; John Rudan, ON;

Purpose: We compare the accuracy and precision of patient-specific plastic guides versus computer-assisted navigation for distal radius osteotomy (DRO). We hypothesize that guides would provide similar accuracy and precision compared to computer-assisted surgery, and that they would be faster to use than navigated surgery.

Method: We used CT scans, computer models, and planned corrections of radii from seven patients who had previously received computer-assisted DRO. The planned correction included the locations and directions of the screw holes for the fixation plate on the intact deformed radius. Using computer-assisted technique, the surgeon drills the holes for the fixation plate using computer navigation before performing the osteotomy; after cutting the radius, the plate is fixated to the distal radius, and the distal radius is distracted until the holes in the proximal radius align with the holes of the fixation plate. A patient-specific guide can be manufactured that fits on the intact deformed radius to guide the drilling of the screw holes. The guide is designed so that it mates exactly with the dorsal surface of the radius. Each guide was designed using custom software and manufactured in ABS plastic using a 3D printer. The surgeon places the guide on the radius and uses a metal drill sleeve in each guide hole to guide the drilling of the plate screw holes. We manufactured urethane plastic phantoms of the seven deformed radii. Our laboratory experiment had six surgeons each perform four computer-assisted and four patient-specific guide procedures on the phantom radii; the specimen and type of guidance were randomly chosen. The time from the start of the procedure to when the shaping of the distal radius was completed was recorded; we did not record the time required to cut and fixate the radius because this time does not depend on the type of guidance used. The plated phantoms were assessed for errors in ulnar variance, radial inclination, and volar tilt as compared to the planned correction.

Results: The results for the computer-assisted procedures were: ulnar variance error (-0.2 +/- 2.0 mm), radial inclination error (-0.9 +/- 6.1 deg), volar tilt error (-0.9 +/- 1.9 deg). The results for the customized jig procedures were: ulnar variance error (-0.7 +/- 0.6 mm), radial inclination error (-1.0 +/- 1.4 deg), volar tilt error (-0.4 +/- 2.2 deg). There were no significant differences detected in the means of the measurements (significance level 0.05) using the two-sample t-test. Significant differences were detected in the variances of the ulnar variance and radial inclination errors (significance level 0.05) using Levene's test. It took (705 +/- 144 sec) to perform the computer-assisted procedures and (214 +/- 98 sec) to perform the customized guide procedures. The differences between the means and variances were statistically significant.

Conclusion: Patient-specific guides are as accurate, more precise, and require less time than computer-assisted navigation for DRO.

98 - Incidence and Severity of Lymphoedema Following Limb Salvage of Extremity Soft Tissue Sarcoma
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Purpose: Lymphoedema is a serious potential complication of the management of extremity soft tissue sarcoma (STS) about which relatively little is known. We aimed to evaluate the incidence of lymphoedema, its severity and associated risk factors following limb salvage for extremity STS.

Method: Lymphoedema severity (EORTC/RTOG) was recorded prospectively in two databases of soft tissue sarcoma patients. Patient's demographics, tumor characteristics, surgical procedures, radiotherapy dosage, complications and functional outcomes (MSTS, TESS) were also prospectively collected. Charts were also retrospectively abstracted for body mass index (BMI) and medical comorbidities.
Results: 289 patients had sufficient data for analysis (158 male). Mean age was 53 (range 16-88). Mean BMI was 27.4 (range: 15.8-52.1). 209 had lower extremity tumors and 80, upper. Mean tumor size was 8.1 cm (range 1.0-35.6 cm). 77 had no adjuvant radiation, 180 had 50 Gy and 32, 66 Gy. The incidence of lymphoedema was found to be 28.7% (58 mild, 22 moderate, 3 severe). Mean MSTS score was 32 (range: 11-35) and TESS was 89.4 (range: 32.4-100). We grouped cases with lymphoedema grade 0-1 and 2-3. Univariate analysis found significant correlations between the severity of lymphedema and tumor size ≥5 cm (p=0.011), deep location (no patient with a superficial tumor had severe lymphoedema, p=0.001), and radiation dosage 50 vs 66 Gy (p=0.021) but not between upper vs lower extremity (p=0.06).

Conclusion: 9% of STS studied developed significant post-treatment lymphoedema. Large, deep tumors and necessity for 66 Gys were most at risk. This group could be targeted for prophylactic intervention.

99 - Unplanned Excision of Soft Tissue Sarcomas – What is the Effect on Patient Outcome?
Peter Ferguson, ON; Cara Emelia Fallis, ON; Anthony Michael Griffin, ON; Benjamin Deheshi, ON; Jay S Wunder, ON;

Purpose: Patients are often referred to tertiary care centers after unplanned excision of soft tissue sarcomas. In situations where the tumour is small and superficial, the situation can often easily be salvaged by re-excision of the tumour bed. However, if the original tumour is large, deep to fascia or directly adjacent to bone or neurovascular structures, the salvage procedure often becomes more complex and morbid. The purpose of this study is to evaluate the effect of unplanned excision of “high-risk” soft tissue sarcomas on patient outcome.

Method: We reviewed our prospectively collected sarcoma database from 1989 to 2006. Patients who underwent definitive resection of a soft tissue sarcoma at our centre were included. Patients were divided into 2 groups based on whether or not they had undergone initial unplanned resection of their tumour prior to referral to our centre for definitive management. Low risk patients had tumours that were less than 5 cm in diameter, superficial to fascia, and not overlying bone or neurovascular structures were excluded.

Results: A total of 1034 patients met inclusion criteria. Of these, 385 (37%) patients had undergone an unplanned excision prior to referral, while 649 (63%) patients were referred to our centre with an intact tumour without prior unplanned excision. There was a higher percentage of high grade (61% vs. 50%) and deep tumours (88% vs. 65%) in the unplanned excision group, but the mean tumour diameter was smaller in the unplanned excision group (5.9 cm) compared to the control group (10.6 cm). There was no difference between the groups in terms of rate of amputation, necessity for flaps for coverage, and local recurrence-free survival. Complications were more common in the control group (34%) than the unplanned excision group (20%, p<0.0005, Chi-square). 5-year overall (p<0.00005, log rank) and metastasis-free (p<0.00005, log rank) survival were higher in the unplanned excision group. There was no difference in TESS, MSTS87 or MSTS93 functional outcome scores between the groups.

Conclusion: Patients referred to a tertiary sarcoma centre after unplanned resection of a soft tissue sarcoma can still be salvaged with appropriate multidisciplinary care. Patients referred after unplanned excision appear to fare at least as well as those initially resected at our centre, and fare better in terms of some outcomes studied. The majority of this difference can likely be explained by significant differences in important prognostic factors such as grade, size and depth between the unplanned excision group and control group initially managed at our centre. Patients referred after unplanned excisions appear not to have as dismal an outcome as has been previously reported.

Paper Session #11 COA Trauma

100 - A Biomechanical Analysis of Lag Screw Position in the Femoral Head for Cephalomedullary Nails Used to Fix Unstable Peritrochanteric Fractures
Paul RT Kuzyk, ON; Radovan Zdero, ON; Suraj Shah, ON; Michael Olsen, ON; James P Waddell, ON; Emil H Schemitsch, ON;

Purpose: Minimizing tip-apex distance (TAD) has been shown to reduce clinical failure of extramedullary sliding hip screws used to fix peritrochanteric fractures. There is debate regarding the optimal position of the lag screw in the femoral head when a cephalomedullary nail is used to treat a peritrochanteric fracture. Some authors suggest the TAD should be minimized as with an extramedullary sliding hip screw, while others suggest placing the lag screw should be placed inferior within the femoral head. The primary goal of this study was to determine which of 5 possible lag screw positions in the femoral head provides greatest mechanical stiffness and/or load-to-failure for an unstable peritrochanteric fracture treated with a cephalomedullary nail. The secondary goal was to determine if there is a linear correlation between implant-femur mechanical stiffness and/or load to failure (dependent variables) with a series of five radiographic measurements (independent variables) of distance from the lag screw tip to the femoral head apex.

Method: Long Gamma 3 Nails (Stryker, Mahwah, NJ) were inserted into 30 left synthetic femurs (Pacific Research Laboratories, Vashon, WA). An unstable-four part fracture was created, anatomically reduced, and repaired using one of 5 lag screw placements in the femoral head: 1) superior (n=6), 2) inferior (n=6), 3) anterior (n=6), 4) posterior (n=6), 5) central (n=6). All specimens were radiographed in the anteroposterior and lateral planes, and radiographic measurements including TAD and a calcar referenced tip-apex distance (CalTAD) were calculated. All specimens were tested for axial, lateral, and torsional stiffness, and then loaded-to-failure in the axial position using an Instron 8874 (Canton, MA). ANOVA was used to compare means of the five treatment groups. Linear regression analysis was used to compare stiffness and load-to-failure (dependant variables) with radiographic measurements (independent variables). A post hoc power analysis was performed.
Results: The inferior lag screw position had significantly greater mean axial stiffness than superior (p<0.01), anterior (p=0.02) and posterior (p=0.04) positions. Analysis revealed significantly less mean torsional stiffness for the superior lag screw position compared to other lag screw positions (p<0.01 all 4 pairings). No statistical differences were noted for lateral stiffness. Superior and central lag screw positions had significantly greater mean load-to-failure than anterior (p<0.01 and p=0.02) and posterior (p<0.01 and p=0.05) positions. There were significant negative linear correlations between stiffness tests with CalTAD, and load-to-failure with TAD. Power was greater than 95% for axial stiffness, torsional stiffness and load-to-failure tests.

Conclusion: Position of the lag screw in the femoral head affects the biomechanical properties of the implant-femur construct. Central placement of the lag screw with minimization of TAD may provide the best combination of stiffness and load-to-failure.

101 - A Provincial Integrated Model to Improve Care for Patients Following Hip Fracture
James P Waddell, ON; Janet McMullan, ON; Rhona McGlasson, ON; Nizar N Mahomed, ON; John Flannery, ON;

Purpose: Fractures of the proximal femur are increasing in incidence as the population ages. In order to address this problem the Province of Ontario, Canada (population 14 million) has advocated an integrated model of care.

Method: A policy to improve the outcome for patients sustaining hip fractures has been developed. It has been implemented in the 14 health regions of the province. The objectives are: 1) All surgical procedures to be performed within 48 hours of patient’s admission to hospital. 2) Surgical treatment of hip fractures must permit unrestricted weight bearing. 3) A structured acute care post-operative course followed by admission to progressive rehabilitation.

Results: Since the implementation of this policy 90% of all hip fracture patients are receiving definitive surgical treatment within 48 hours of admission. Site variations are identified and remedial actions implemented for those hospitals which fail to meet this target. Acute care length of stay following hip fracture has declined from a mean of 17 days to a mean of 8 days. The number of patients with hip fractures returning to their pre-injury residence has increased significantly from approximately 35% to 70% at 3 months post-fracture.

Conclusion: A structured program for hip fracture care can be developed in large population areas and has been implemented for the approximate 10,000 patients sustaining hip fractures annually within our jurisdiction. This model should be broadly applicable to other health regions.

102 - The Dynamics of Outcome Assessment: An Analysis of the SPRINT Tibial Fracture Trial
Nicole Simunovic, ON; SPRINT Investigators, ON;

Purpose: The purpose of this study was to evaluate how outcome assessment committees of various sizes, and the biases and personalities of its members, potentially impact a trial’s results.

Method: We conducted a retrospective analysis of the available individual and consensus data from an adjudication committee in a multinational trial (the SPRINT trial) of fracture fixation alternatives. The trial committee members included six members (5 surgeons, 1 methodologist) who independently determined the outcome of reoperation, and any discordant cases were discussed in the committee until a consensus was achieved. We described the pattern of agreement among adjudicators, modeled the adjudication process, and predicted the results if a smaller committee had been used. We also tested for adjudicator biases based upon their preferences for reamed or unreamed intramedullary nails, the presence of a potentially dominant adjudicator, and evaluated the resource implications of reducing the size of an adjudication committee.

Results: Overall, committee member agreement was moderate (Kappa Free=0.6). We found that reducing the number of adjudicators from six to three would have changed the consensus outcome in less than 15% of cases. Regardless of committee size, per-patient analyses also demonstrated very little change in the final study results across all fracture types or in the open fracture subgroup. Results from the original SPRINT adjudication indicated a significant decrease in the rate of reoperations associated with reamed intramedullary nailing among patients with closed fractures (relative risk 0.65; 95% confidence interval 0.46 to 0.93; p=0.02). Under the model, in committee sizes of three or less persons, these estimates of treatment effect were no longer significant. There was a significant difference between adjudicators with respect to the number of times their independent decision was in the minority but nevertheless became the final consensus decision (p=0.046), suggesting a dominant adjudicator was present in the committee. There were large predicted savings in cost and time with a reduced committee size.

Conclusion: In this study, smaller committees (i.e., four or five rather than six adjudicators) would likely have produced similar results, substantially reducing costs of research.

103 - Fluid Lavage of Open Fracture Wounds (FLOW): A Randomised Blinded, Multicentre Pilot Trial
Brad Petrisor, ON; FLOW Investigators, ON;

Purpose: The optimal choice of irrigating solution or irrigating pressure in the initial management of open fracture wounds remains controversial. FLOW compared the effect of castile soap versus normal saline, and low versus high pressure pulsatile lavage on one year re-operation rates in patients with open fracture wounds.

Method: We conducted a multicenter, blinded, two-by-two factorial, pilot randomized trial of 111 patients with open fracture wounds receiving either castile soap solution or normal saline and either high or low pressure pulsatile lavage. The primary outcome,
reoperation within one year, included infections, wound healing problems, and nonunions. Secondary outcomes included all operative and non-operative infections, wound healing problems, nonunion and functional outcomes. We followed the intention to treat principle. **Results:** Eighty-nine patients (80.2%) completed the 12-month follow-up. As anticipated in this small-sample-size pilot study, results were compatible with substantial benefit and substantial harm: the hazard ratio (HR) for reoperation with castile soap was 0.77, 95% CI 0.35 to 1.69, p=0.52; with low pressure lavage, the hazard ratio for the risk of reoperation was 0.56, 95% CI 0.25 to 1.27, p=0.17. Secondary outcomes showed a significant relative risk reduction for nonunion of 63% in favour of castile soap (p=0.036), and a trend for a relative risk reduction for nonunion of 44% in favour of low pressure lavage (p=0.22). **Conclusion:** The FLOW pilot study suggests the possibility of an important reduction in reoperation rates for both castile soap and low pressure pulsatile lavage. Our findings provide compelling rationale for continued investigation in a pivotal FLOW trial of 2280 patients.

**104 - Functional Outcomes Following Intramedullary Nailing of Trochanteric Hip Fractures: A Pilot Multicentre, Randomised Controlled Trial**

Mohit Bhandari, ON; Alicja Bojan, SE; Carl Eckholm, SE; Ole Brink, DK; Anthony Adili, ON; Sheila Sprague, ON; Nasir Hussain, ON; Anders Joensson, SE; REGAIN Investigators, ON;

**Purpose:** The popularity of intramedullary nails (IMN) for trochanteric hip fractures has grown substantially with little supportive evidence that IMN are superior to conventional sliding hip screws (SHS). We aimed to assess the impact of SHS or IMN intramedullary nailing on functional outcomes and rates of re-operation in elderly patients with fractures.

**Method:** We conducted a multi-center, pilot randomized trial including three clinical sites across Sweden, Denmark, and Canada. We randomized 85 elderly patients with stable and unstable trochanteric hip fractures to either SHS or an IMN. The primary outcome, revision surgery, was independently adjudicated at one year. Secondary functional outcomes included the Parker Mobility Score (PMS), the Merle D’Aubigne Score, the Short Form-12 (SF-12) and the Euroqol-5D.

**Results:** Eighty-five patients were enrolled. Fifteen patients died prior to the one year follow up. Across treatment groups, patients did not differ in age, gender and fracture type. The overall revision risk was 11.6% (8/69) and did not differ significantly between groups (IMN: 5; SHS: 3). Patients treated with IMN had significantly higher Merle D’Aubigne function subscores at 6 (p<0.01) and 12 months (p=0.05). Gamma3 nails approached significantly higher scores in the Parker mobility score at 6 (p=0.08) and 12 months (p=0.056). Non-significant differences were identified in the SF-12 and Euroqol-5D quality of life measures; however, in both scores, the Gamma3 nailed tended to higher scores than the sliding hip screw.

**Conclusion:** Our findings of early functional gains without increased risk of revision surgery support the increased popularity of IMN for the management of trochanteric hip fractures in elderly patients.

**105 - A Biomechanical Comparison of Static versus Dynamic Lag Screw Modes for Cephalomedullary Nails Used to Fix Unstable Peritrochanteric Fractures**

Paul RT Kuzyk, ON; Radovan Zdero, ON; Suraj Shah, ON; Michael Olsen, ON; James P Waddell, ON; Emil H Schemitsch, ON;

**Purpose:** Cephalomedullary nails rely on a large lag screw that provides fixation into the femoral head. There is an option to statically lock the lag screw (static mode) or to allow the lag screw to move within the nail to compress the intertrochanteric fracture (dynamic mode). The purpose of this study was to compare the biomechanical stiffness of static and dynamic modes for a cephalomedullary nail used to fix an unstable peritrochanteric fracture.

**Method:** Thirty intact synthetic femur specimens (Model #3406, Pacific Research Laboratories, Vashon, WA) were potted into cement blocks distally for testing on an Instron 8874 (Instron, Canton, MA). A long cephalomedullary nail (Long Gamma 3 Nail, Stryker, Mahwah, NJ) was then inserted into each of the femurs. An unstable four-part fracture was created, anatomically reduced, and the cephalomedullary nail was reinserted. Mechanical tests were conducted for axial, lateral, and torsional stiffness with the lag screws in: 1) static and 2) dynamic modes. A paired student’s t test was used to compare the 2 modes.

**Results:** The axial stiffness of the cephalomedullary nail was significantly greater (p<0.01) in the static mode (484.3±80.2N/mm) than in the dynamic mode (424.1±78.0N/mm) (Fig.2A). Similarly, the lateral bending stiffness of the nail was significantly greater (p<0.01) in the static mode (113.9±8.4N/mm) than in the dynamic mode (109.5±8.8N/mm). The torsional stiffness of the nail was significantly greater (p<0.01) in the dynamic mode (114.5±28.2N/mm) than in the static mode (111.7±27.0N/mm).

A post hoc power analysis with #945=0.05 and #946=0.20 revealed that the paired t test on 30 samples was sufficiently powered to determine a difference in mean axial stiffness of 33.0N/mm (6.8% of static stiffness), a difference in mean lateral bending stiffness of 3.6N/mm (3.2% of static stiffness) and a difference in mean torsional stiffness of 3.4N/mm (3.0% of static stiffness).

**Conclusion:** Our results show that there is a 60N/mm reduction in axial stiffness of the cephalomedullary nail when the lag screw is changed from static to dynamic mode. This represents a 12.4% reduction in axial stiffness with a change from axial to dynamic modes which may be clinically significant. The differences in lateral (4.4N/mm, 3.9%) and torsional (2.8N/mm, 2.4%) are small enough that they are likely not clinically significant. We felt that a difference of greater than 10% in axial stiffness and a difference of greater than 5% in lateral or torsional stiffness would be clinically significant. Our study was adequately powered to detect these differences. Given the significant reduction in axial stiffness with dynamization of the cephalomedullary nail construct, we recommend use of the static mode when treating unstable peritrochanteric fractures with a cephalomedullary nail.

**106 - Prospective Multicentre Randomised Trial Comparing the Less Invasive Stabilisation Skeletal System(LISS) to the Mini Invasive Dynamic Condylar System(DCS) for Distal Femoral Fracture**
**Purpose:** Surgical fixation distal femoral fractures has been associated with nonunion and varus collapse. The soft tissue stripping resulted from this fracture and caused by the surgical approach have been factor-associated with delayed union and infection. The limited soft tissue exposure has been lauded as a solution to this fracture. However, it has occurred with new fixation as well (locked plate). This study is an attempt to look at the fixation from the surgical approach prospective. Does the liss system improve the results of this difficult fracture? Is there truly a difference in the outcome of this fracture utilizing the locked plate system or the perceived difference due to surgical mini-invasive approach.

**Method:** One hundred and forty patients were screened, and only 53 were randomized and treated in six academic centers over five years. All 3 c fractures were excluded from the study as they were felt not to be treatable by the dcs device, but they were treated and fixed appropriately. Thirty-five females and 18 males were included and appropriately randomized.

**Results:** Fifty-three patients were randomized, 28 had the liss implant while 25 had the dcs utilized. There were three nonunions in the liss group, plus two patients required an early reoperation in the early postoperative periods (second- fifth post op. day) due to an early loss of reduction. Further more, one patient developed a knee arthrofibrosis that required arthroscopic joint release with subsequent implant failure. That necessitated a reoperation. In the dcs group there was only one nonunion, that required reoperation. This translated into reoperation rate of 21% in the liss group compared to 4% with dcs.

**Conclusion:** This prospective multicenter randomized trial showed a significant difference when comparing the liss device to the dcs system in minimal invasive approach of distal femoral fractures fixation.

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**107 - A Biomechanical Assessment of Locking Plates for Repairing Proximal Humerus Fractures**

**Emil H Schemitsch, ON; Jonathan Lescheid, ON; Radovan Zdero, ON; Suraj Shah, ON; Paul RT Kuzyk, ON;**

**Purpose:** Optimal fixation for comminuted proximal humerus fractures is controversial. Complications using locked plates have been addressed by anatomic reduction or medial cortical support. The current study measured relative mechanical contributions of varus malalignment and medial cortical support.

**Method:** Forty synthetic humeri were divided into three groups, osteotomized, and fixed at 0, 10, and 20 degrees of varus malreduction with locked proximal humerus plates (AxsOS, Global model, Stryker, Mahwah, NJ, USA). This simulated mechanical medial support with the cortex intact. Axial, torsional, and shear stiffness were experimentally measured. Half of the specimens in each of the groups underwent a second osteotomy to create a segmental defect which simulated loss of medial support with the cortex removed. Axial, torsional, and shear stiffness experiments were repeated, followed by shear load to failure in 20 degrees of abduction.

**Results:** For isolated malreduction with the cortex intact, the repair construct at 0 degrees showed statistically equivalent or higher axial, torsional, and shear stiffness than other groups assessed. Subsequent removal of cortical support in half the specimens resulted in a drastic effect on axial, torsional, and shear stiffness at all varus angles. Repair constructs with the cortex intact at 0 and 10 degrees resulted in mean shear failure forces of 12965.4 N and 9341.1 N, respectively. These were statistically higher (p<0.05) compared to most other groups tested. Specimens failed mainly by plate bending as the femoral head was pushed down medially and distally.

**Conclusion:** Anatomic reduction with the medial cortex intact was the stiffest construct after a simulated two-part fracture. This study also supports the practice of achieving medial cortical support by fixing proximal humeral fractures in varus if necessary. This may be preferable to fixing the fracture in anatomic alignment when there is a medial fracture gap.

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**108 - Radiographic Union Scale for Tibial (R.U.S.T.) Fracture Healing Assessment: Preliminary Validation**

**Mohit Bhandari, ON; Bauke W Kooistra, ON; Jason Busse, ON; Stephen D Walter, ON; Paul Tornetta III, MA; Emil H Schemitsch, ON;**

**Purpose:** We aimed to preliminarily validate a newly developed system, the radiographic union scale for tibial (RUST) fracture healing. We hypothesized that RUST would demonstrate better inter-rater reliability than assessment of the number of cortices bridged and correlate with functional outcomes at least as strongly as a surgeon's assessment of cortical bridging.

**Method:** Three blinded orthopaedic trauma surgeons independently assigned a RUST score and a number of cortices bridged by callus (zero to four) to each set of AP and lateral radiographs at each follow up period. RUST is scored from four (definitely not healed) to 12 (definitely healed) based on the presence or absence of callus and of a visible fracture line at the total of four cortices visible.

**Results:** For 549 sets of reviewed radiographs, inter-rater reliability for RUST scores were found to be substantially higher than for assessment of the number of cortices bridged (intraclass correlation coefficient=0.84; 95% CI, 0.80-0.87 versus kappa = 0.73; 95% CI, 0.64 - 0.81, respectively). Both methods of assessing radiographic healing were strongly correlated with weight-bearing status (r and p>0.50), moderately correlated with patient-reported functional recovery and the SF-36 Physical Functioning component scores (r and p>0.30), and minimally correlated with HUI Mark II scores, return to work, and the SF-36 Role Physical component and Physical Component Summary scores (r and p>0.10). Neither assessment was correlated with patient-reported pain scores. All correlations were similar for RUST and the number of cortices bridged.

**Conclusion:** This study provides preliminary evidence that RUST can be used as a valid and reliable alternative assessment of tibial fracture healing.
**Paper Session #12 COA Hip Reconstruction**

**109 - The Variability of Anatomical Cup Positioning Following Total Hip Arthroplasty**

**Purpose:** The purpose of this study was to determine if correlation exists between acetabular cup positioning and factors relating to the surgeon and patient.

**Method:** Data for 2063 patients who underwent primary or revision THA from 2004 -2008 were compiled. The post-op anteroposterior (AP) and cross-table lateral radiographs for each patient were obtained. The AP radiograph was measured using Hip Analysis Suite to calculate the cup abduction and version angles (version direction determined separately). Acceptable ranges were 35-45° for abduction, and 5-20° for version. Correlations were then determined with SPSS™ software.

**Results:** There were 1980(96%) qualifying patients. There were 1025(52%) acetabular cups that fell within the 35-45° abduction range, and 1287(70%) cups in the 5-20° version range. Regression analysis showed that the only independent predictor of acceptable abduction angle was the surgical approach (p<0.001). Posterior lateral approach was the most accurate (57% acceptability). In contrast to the posterolateral, the MIS (2 incision) approach was 3 times (95%C.I. 1.5-5, p=0.001), and the mini anterolateral approach 2.5 times (95%C.I. 1-6.5, p=0.035) more likely to have unacceptable abduction angles. The only independent predictor of acceptable version was the performing surgeon (p<0.001), with higher volume surgeons showing greater accuracy.

**Conclusion:** The posterolateral approach was superior to MIS (2 incision) and mini anterolateral approaches for acceptable abduction angle, and surgeon volume influenced version angle acceptability. Further analysis on variables and their influence on cup position at a lower volume medical center would provide a valuable comparison.

**110 - Early Experience of Anterior Approach with Assisted Hip Arthroscopy for Femoroacetabular Impingement**
Paul E Beaulé, ON; Kamal Banga, ON;

**Purpose:** The surgical correction of FAI deformity is a well accepted treatment in patients presenting with hip pain with associated labral-condral damage. The anterior approach with assisted hip arthroscopy provides access to the anterior head-neck junction with potentially quicker recovery for patients. The purpose of this study is to present the safety and efficacy of this approach in performing impingement surgery.

**Method:** Forty-eight Huerter procedures were performed in 45 patients (13 males and 32 females). Mean age was 42.09 years (range, 21-65 years), and mean BMI was 24.31 (range, 21-33). The scope was performed first to deal with intra-articular damage. All patients were diagnosed with CAM type FAI with labral pathology based on MRI arthrogram with an alpha angle > 50.5 degrees.

**Results:** At a mean follow-up of 21.8 months (range 12-30 months), Harris Hip scores improved from 64.66 (range, 42.0-93.0) to 79.97 (range, 47.0-96.0). There were 5 re-operations at a mean time of 15.2 months (range, 4-22). One had a repeat hip scope for intra-articular adhesions, and another for recurrent traumatic tear of the labrum. Three cases with residual hip dysplasia had corrective surgery with a peri-acetabular osteotomy at an average of 16.67 months (range, 15-18 months).

**Conclusion:** Overall, we have found this to be a reliable, safe and reproducible approach to the treatment of FAI. This is a day care procedure as compared to the classic open procedure. Unorrected hip dysplasia in the presence of a CAM deformity is a risk factor for early failure.

**111 - Clinical and Radiographic Evaluation of Device Failures Following Metal-on-Metal Hip Resurfacing**

**Purpose:** Metal-on-Metal (MOM) hip resurfacing is a popular alternative to conventional hip arthroplasty. The purpose of the present study is to compare patient characteristics and radiographic findings for revision versus non-revision cases treated at a single center with a MOM resurfacing device.

**Method:** Eighty-nine MOM resurfacing arthroplasties were performed between December 2001 and June 2006. Subjects were assessed for implant revision status, age, gender, weight, operative side, primary diagnosis, femoral head size, and time to revision. Postoperative radiographs were assessed for acetabular cup inclination and femoral stem inclination relative to the femoral neck.

**Results:** Thirteen of 89 hips (14.6%) have required revision to date with follow-up ranging from 4 (a revision) to 91 months. Female gender, smaller implant size, and a diagnosis of osteonecrosis were all associated with lower device survival. A significant difference in acetabular cup angle was observed between revised and non-revised hips. However, this difference can largely be attributed to two outliers in cup position associated with early migration and the difference became non-significant when these outliers were excluded. No significant difference was found in stem angle between revised and non-revised hips. The revision rate for the first 25 hips was 24% versus 8% for the next 64 hips. Females accounted for 56% of subjects 1-25 and 23% of subjects 26-89. Seven of the 8 failures for the first 25 procedures occurred beyond 4 years follow-up. Only 2 early device failures (<2 yrs) were identified and both were in the 26-89 subgroup.

**Conclusion:** Despite representing only 33% of included subjects, females accounted for 62% of revision procedures. An apparent learning curve was identified by a lower device survival proportion for the first 25 hips versus hips 26-89. However, this learning curve was not associated with failures which could be attributed to acetabular or femoral component malpositioning and is likely explained by the higher proportion of females enrolled early in the study. Taken together, we propose the apparent "learning curve" exhibited in our study is not wholly technical in nature but rather influenced by changes in patient selection over time by the operative surgeon.
112 - Metal Ion Levels in Patients with Large Head Metal-on-Metal Total Hip Prosthesis
John Antoniou, QC; Alain Petit, QC; Fackson Mwale, QC; David J Zukor, QC; Olga L Huk, QC;

Purpose: Several studies have shown elevated levels of metal ions in blood of patients with metal-on-metal (MM) total hip arthroplasty (THA). To minimize wear, the elasto-hydrodynamic theory suggests wear reduction for larger diameter head bearings. This significant reduction in wear has been demonstrated in hip simulators for the 36 mm-head compared to the 28 mm-head prosthesis. However, the survival of larger head MM THAs and the levels of metal ions in the blood of patients having these implants are still to be determined.

Method: Fifty (50) patients (56 hips) who received a DePuy Ultamet™ MM hip bearing (40/44 mm-head) at our Institution between July 1st 2007 and August 31st 2008 were included in the study. Clinical and radiologic data were collected pre-operatively as well as at 6-8 weeks, 4-6 months, and 1 year postoperatively. Results were compared to those of subjects (65 patients, 71 hips) who received a 36 mm-head prosthesis. Cobalt (Co) and chromium (Cr) concentrations were measured at 1 year post-operatively in the blood of patients by ICP-MS. Since Co and Cr ions have the potential to induce irreversible biochemical damage to macromolecules, the levels of oxidative stress markers (total antioxidants and lipid peroxides) were measured in the plasma of these patients.

Results: At their 1-year post-operatively follow-ups, all patients were doing well and no sign of osteolysis was observed on X-rays. Harris Hip Score increased in both groups with a tendency to higher score in the 40-44 mm group compared to the 36 mm group. Activity score also increased in both groups after 1 year without statistical significant differences. Results also show that the levels of Co and Cr ions increased significantly in both groups compared to the Pre-OP control group. The levels of Co were also significantly higher in patients with large head arthroplasty (40 and 44 mm-head) compared to those of the 36 mm-head group (p=0.012). The levels of Cr were similar in both the large head and the 36 mm-head group (p=0.41). Finally, results show that there were no differences in the levels of total antioxidants and peroxides between the 40-44 mm group and the 36 mm group. Moreover, there was no increase in the level of these markers of oxidative stress compared to the Pre-OP control group.

Conclusion: The present study shows that at 1-year post-operatively, patients with large 40-44 mm-head THA had comparable clinical outcomes than those with 36 mm-head prosthesis. However, the levels of Co ions were significantly higher in these patients compared to patients with 36 mm-head THA. This suggests a higher health risk for these patients due to the presence of these ions. However, there were no effects on the levels of oxidative stress markers in the blood of these patients, suggesting that there is no increased risk at short-term. In conclusion, due to the high level of Co ions, longer follow-ups are required to conclusively determine the outcomes of the patients and the survivorship of these new bearings.

113 - Hip Centre Restoration with Protusio Cup in Revision Hip Arthroplasty
André Nzouc, QC; Jean-Michel Laffosse, QC; Alain Roy, QC; Martin Lavigne, QC; Pascal-André Vendittoli, QC;

Purpose: Massive cavitary and segmental bone defects of the medial wall in revision arthroplasty are usually managed with large auto and/or allograft in association with a cemented or a cementless cup. To obtain a satisfactory hip center reconstruction with such a procedure can be sometimes challenging and the complications rate can be high. One other option is the use of a cup with a medial expansion (“protusio cup”) to treat the medial bone defect.

Method: We carried out a retrospective study including 21 consecutive acetabular revisions arthroplasties using a cementless Converge Protrusio™ cup (Zimmer, Warsaw, IN, USA). Clinical outcomes were assessed by Harris Hip Score (HHS), WOMAC index and SF-12. Hip centre was assessed on anteroposterior (AP) view and the reconstruction was considered as satisfying when its location was located from -10 to + 10 mm proximally (y axis) and/or medially (x axis) in comparison with ideal theoretical hip center location. Cup migration and modification of abduction angle were considered as significant when there were respectively >4 mm and to >4° in comparison with the immediate postoperative AP view.

Results: At the last follow up [radiological data: 71.6 months (24-128.3) and clinical data: 72.1 months (24-129.5)], two patients were died and there were no lost of follow up. The mean HHS was 79.4% (52-100), WOMAC 82% (46-100), SF-12 52 (23-71) and 44 (18-65). Bone defect were filled with cancellous bone chips allograft in 16 cases and bulk bone allograft was used in only two cases to manage a large segmental defect of the roof. Bone graft integration was completed in all cases. The mean abduction cup angle was 43.6° (32-60). A satisfying hip centre positioning was obtained in 19 cases on x axis and in 10 cases on y axis, in all the remaining cases, we noted an improved implant positioning. The complications were: recurrent dislocation in one case (successfully revised with a constrained liner), infection in two cases (1 treated conservatively and the other one revised in two times procedure) and Brooker’s type III and IV ectopic ossifications in three cases. A significant cup migration occurred in only one case at nine years but was not revised because of painless. No case required revision for aseptic loosening.

Conclusion: Protusio cups appear as a reliable procedure to manage bone loss in acetabular revision. The revision procedure is widely simplified by reducing the use of the massive allograft and by promoting a satisfying hip center reconstruction to allow an optimal biomechanical joint functioning. Moreover, the cementless fixation in contact with patient acetabular bone makes more easy bone integration.

114 - Femoral Neck Narrowing after Metal-on-Metal Hip Resurfacing
Sanket Diwanji, QC; Jean-Michel Laffosse, QC; Kim Aubin, QC; Martin Lavigne, QC; Pascal-André Vendittoli, QC;

Purpose: Femoral neck narrowing (FNN) has been reported after metal-on-metal hip resurfacing (HR). It is significant (>10%) in a number of cases (from 0 up to 27.6%). Its origin remains unclear, but bone remodelling, impingement, head necrosis and osteolysis
have been incriminated. The aims of this study were to assess these issues and describe their consequences in a prospective series with a minimum follow-up of five years.

**Method:** Fifty-seven HRTs in 53 patients (30 men, 23 women, average age 49.2±8.4 years) were included prospectively with clinical (WOMAC, UCLA activity score) and radiological evaluation at one, two and five years. All patients received the Durom™ resurfacing system (Zimmer, Warsaw, IN, USA), with cementless acetabular cup and cemented femoral implant. All cases were undertaken via a posterior approach. Femoral and acetabular implant positioning was assessed. The neck-to-head prosthesis (N/H) ratio was calculated at the junction of the neck with the femoral component and at mid-distance between the neck junction and the inter-trochanteric line (N1/2/H) on anterior-posterior view. Ion concentrations (chromium, cobalt and titanium) were measured at 12 months. We considered p<0.05 as the significance level.

**Results:** The N/H ratio decreased significantly at one, two and five years in comparison to the postoperative data (p<0.01 for all parameters) and N1/2/H declined significantly only at one and two years (p=0.003 and p=0.03, respectively). There was no difference in the N/H ratio or N1/2/H between two and five years. We encountered no deleterious consequences of FNN on clinical outcome, and no significant relationship with cup positioning, gender, body mass index or level of activity. Femoral positioning in valgus was associated with a decrease in N1/2/H at one and two years (p=0.02), whereas the N/H ratio tended to be lower when cobalt concentration was elevated (p=0.08). Significant FNN was observed in two cases at two years (-12.9% and -11.1%) with a localized and progressive femoral anterior-superior notch absent on immediate postoperative X-rays. At five years, we noted three other cases with circumferential FNN, limited at the junction neck-cup area (average narrowing around -20% between two and five years). One of these cases presented a femoral stem fracture. Osteonecrosis was confirmed during surgical revision.

**Conclusion:** In the current group, FNN was seen infrequently up to five years after surgery (9%). Mechanically-induced remodelling should be differentiated from overall FNN which may be due to femoral head necrosis. In this case, revision could be proposed before implant failure or femoral loosening. Impingement causes very early and localized FNN at the upper part of the neck; for these patients, simple observation should be the rule, all the more since they are usually pain-free and rarely disabled.

### 115 - Minimum Ten-year Results of a Dual Offset Uncemented Tapered Femoral Stem for THR

**Richard W McCallen, ON; Robert B Bourne, ON; Kory D Charron, ON; Steven JM MacDonald, ON; Cecil H Rorabeck, ON;**

**Purpose:** The Synergy femoral component was introduced in late 1996 as a second generation titanium proximally porous-coated tapered stem with dual offsets (standard & high) to help better restore femoral offset at THR. The purpose of this prospective study was to evaluate the long-term (minimum 10 year) clinical and radiographic results and survivorship of this second-generation femoral component at our institution.

**Method:** From December 1996 to December 1999, 256 cementless Synergy femoral components were inserted and followed prospectively in 254 patients requiring THR. 185 were standard offset stems (72.3%) while 71 stems (27.7%) were high offset. The Squeaky Ceramic Hip—A Striking Problem

**Ross K Leighton, NS; Kelly Trask, NS; Gwendolyn Dobbin, NS;**

**Purpose:** The ideal bearing surface for total hip arthroplasty is still an area of debate. Increasing numbers of total hip replacements are being done in the younger patient population. Ceramic-on-ceramic bearings have gained popularity due to their low wear rate; however, ceramic fractures with subsequent catastrophic failures have been reported and squeaking of ceramic hips is an emerging problem. This study reports on early results of ceramic-on-ceramic total hip replacements.

**Method:** This is a study analyzing prospectively collected data for 120 alumina-on-alumina total hip replacements with minimum follow-up of 24 months. Average age at time of surgery was 49 years. The main outcome of the study was to identify complications related to the prostheses. Standard outcome measures (SF-12, Harris Hip Score, and WOMAC) were also collected at clinic visits.

**Results:** All patients received either a Stryker Trident acetabular cup with Secure-fit Plus stem or Depuy Pinnacle cup with an AML stem. Average follow-up was five years (range: two – nine years). No revisions were performed for loosening or catastrophic failures. No wear, loosening, or osteolysis was seen on radiographs. The SF-12, WOMAC, and Harris Hip scores were not significantly different from other reported hip series. The most common complication has been the “squeaking” hip. To date we have had six squeaky hips in our centre, three of which have been revised. All the squeaking hips received the Trident acetabular cup (Stryker) which has a
Circumferential metal lip to protect the ceramic bearing. This metal flange can affect range of motion and predispose patients to earlier impingement (particularly if a minus 3 head is utilized). One patient with a DePuy hip complains of intermittent pain and radiographs show some fragmentation, but the hip has not been revised.

**Conclusion:** Ceramic-on-ceramic bearing surfaces in total hip arthroplasty may provide a more durable prosthesis with outcomes similar to standard THA, especially in young and active patients; however, caution should be used if considering the Stryker Trident shell due to the large number of “squeaky hips”.

**117 - Femoral Neck Fractures with a Modular THR System**

**Purpose:** To report a series of unexpected femoral neck failures in a series total hip replacement surgeries using a modular femoral component.

**Method:** A series of 443 hip replacement patients received modular necks as part of a non cemented hip replacement with ceramic articulations at the acetabulum and femoral head interface. The first implant of the device was on June 8, 2004 and the last on June 12, 2009. Ninety-one of those patients were enrolled in a RSA study of component stability within the proximal femur.

**Results:** The index fracture of a femoral neck occurred on March 8, 2009 when the patient (28 months post hip replacement) reported a fall. Subsequently five patients have had a fracture of the modular neck. There were five fractures within the RSA study group and one within the non study group (all occurred 17 months to 30 months post op). All fractures were long necks (10.5 mm). There was no difference in femoral component micromotion as measured with RSA between the fractured group and the unrevised group.

**Conclusion:** Initial non-destructive testing of one retrieval revealed fatigue failure of the femoral neck. An independent study of all relevant data was implemented which included destructive testing of the implants and clinical data with respect to patient activity. We report the outcome of all those investigations.

**118 - Hip Resurfacing Arthroplasty: The Effect of Anterior and Posterior Notching on Fracture Resistance**

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

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

**Results:** Testing Group Mean load to failure Significance (p-value) Anterior 2mm 3926.61 ± 894.17 .843 Anterior 5mm 3374.64 ± 345.65 .155 Neutral (Control) 4539.44 ± 786.44 - Posterior 2mm 4208.09 ± 1079.81 .994 Posterior 5mm 3988.06 ± 728.59 .902 Superior 5mm 2423.07 ± 424.17 .001 Anterior 5mm in 25° flexion 3048.11 ± 509.24 .027 Posterior 5mm in 25° extension 3104.62 ± 592.67 .038 Our data suggests that anterior and posterior two mm or five mm notches are not significantly weaker in axial compression. Anterior and posterior five mm notches are significantly weaker in flexion/extension (p=0.027/ p=0.038). The five mm superior notch group was significantly weaker with axial compression supporting previous published data (p=0.001).

**Conclusion:** We conclude that anterior or posterior two mm notching of the femoral neck has no clinical implications, however five mm anterior or posterior femoral neck notching significantly weakens the femoral neck. Fracture is more likely to occur with stair ascent or activities involving weight bearing in extension. Hip resurfacing is commonly performed on active patients and five mm neck notching has clinically important implications.

**Paper Session #13 COA Paediatrics**

**119 - C1 Lateral Mass Screw Fixation in Children: Indications, Outcomes, and Technique in 11 Consecutive Patients**

**Purpose:** Upper cervical spine stabilization in children can be challenging due to anatomic abnormalities such as incomplete posterior elements, vertebral artery variability and small patient size. Several techniques have been described for stabilization of the upper cervical spine, each with its own advantages and disadvantages. Since the introduction of the technique by Harms, many authors have shown C1 lateral mass screws to be safe and effective in the stabilization of the upper cervical spine in adults. No large series of
paediatric C1 lateral mass screw fixation has been reported in the literature. The purpose of this study was to describe the indications, technique, and outcomes of C1 lateral mass screw fixation in a consecutive series of 11 paediatric patients.

**Method:** A database generated retrospective review of all patients who underwent C1 lateral mass screw fixation as part of an upper cervical spine stabilization construct was performed. In all patients the C2 dorsal root ganglion was sacrificed. Patient demographics and clinical outcomes were obtained through chart review. Radiographs immediately post-operatively, at six-weeks, three-months, and final follow-up were reviewed.

**Results:** Eleven consecutive paediatric patients underwent bilateral C1 lateral mass screw fixation for a variety of conditions including C1-C2 instability, deformity, congenital malformation, trauma, as well as revision surgery. The average age was 10 years (range 4 to 16 years) with a mean follow-up of 11 months (range 6 – 18 months). There were no iatrogenic vertebral artery, hypoglossal nerve or spinal cord injuries. All 11 patients had solid fusion clinically and radiographically, with no loss of fixation. The C2 dorsal root ganglion was sacrificed in all patients with resulting minor occipital parasthesia that progressively diminished in severity.

**Conclusion:** This is the largest series of consecutive patients reported in the literature to date showing that the technique is safe and effective, with acceptable morbidity when applied to the paediatric population. We believe that C1 lateral mass screws offer significant advantages over traditional fixation techniques when the C1 vertebra is to be included in an upper cervical instrumented construct.

120 - Long-term Results of the Galveston Technique for Pelvic Fixation in Neuromuscular Spinal Deformity


**Purpose:** Posterior spinal fusion (PSF), with or without anterior spinal fusion (ASF), in conjunction with Luque rod instrumentation (LRI) and Galveston technique is a common procedure in neuromuscular spinal deformity. However, few studies have specifically studied the long-term results and complications of Galveston technique. The purpose of this study was to analyze the long-term results of Galveston technique in combination with PSF, with or without ASF, and LRI in the correction of neuromuscular spinal deformity. We were specifically interested in the stability of the distal foundation, lumbosacral fusion, correction of the associated pelvic obliquity, and complications.

**Method:** Analyzing our Pediatric Orthopaedic Spine Database between 1992-2006, we identified 107 consecutive patients with a neuromuscular spinal deformity who underwent a PSF, with or without ASF, and LRI including Galveston technique, who had a minimum of 2 years postoperative follow-up. There were 55 females and 52 males with a mean age at surgery of 13.5 ± 3.5 years. The mean follow-up was 7.8 ± 3.7 years. We analyzed the coronal and sagittal plane alignment and pelvic obliquity preoperatively, postoperatively, and at last follow-up. We recorded any complications directly related to the Galveston technique.

**Results:** The mean preoperative major curve was 76 ± 21 degrees. At last postoperative follow-up, this measured 33 ± 16 degrees. The mean preoperative pelvic obliquity was 17 ± 10 degrees and at last follow-up 7 ± 6 degrees. Seven patients (6.5%) had Galveston technique complications: three rod breakages, three implant distal migrations and one patient with both rod breakage and distal migration. These occurred late and only one patient required revision surgery.

**Conclusion:** The Galveston technique is an excellent procedure for lumbosacral stabilization in patients with neuromuscular spinal deformity. It provides a solid distal foundation for a lumbosacral fusion and for correction of spinal deformity and pelvic obliquity, with minimal complications.

121 - Extension Type II Supracondylar Humerus Fractures; A Radiographic Outcomes Study of Closed Reduction and Cast Immobilisation

Tristan Camus, NS; Ronald El-Hawary, NS; Brent MacLellan, NS; P. Christopher Cook, NS; J. Lorne Leahey, NS; John C Hyndman, NS;

**Purpose:** The treatment of extension type II pediatric supracondylar humerus fractures remains controversial. Some argue that closed reduction and cast immobilization is sufficient to treat these fractures, while others advocate closed reduction and pinning. The purpose of this radiographic outcomes study was to determine whether closed reduction and cast immobilization could successfully obtain and maintain appropriate position of extension type II supracondylar humerus fractures.

**Method:** The radiographs of 1017 pediatric patients treated for supracondylar fractures between 1987 and 2007 were retrospectively reviewed. Pre-reduction, immediate post-reduction, and final radiographs of 155 extension type II fractures were measured in order to assess the position and alignment of the fracture fragments. Measurements included the anterior humeral line, humeral-capitellar angle, Baumann’s angle, the Gordon index, and the Griffet index. The latter two indices calculate the rotational instability of the fracture, which can be predictive of reduction loss. Patients were excluded if insufficient radiographs failed to allow complete assessment of the measurement parameters, or if open reduction was required.

**Results:** The average age of the subjects was 5.3 years (range 1-13 years) and had a mean follow-up of 5.3 months. Analysis of the final radiographs demonstrated that in 80% of subjects, the anterior humeral line remained anterior to the mid third segment of the capitellum (radiographic extension deformity), the mean humeral-capitellar angle was 23.8° (range -11°-50°), the mean Baumann’s angle was 79.4° (range 62°-97°), the mean Gordon index was 4.59%, and 44% of subjects had a Griffet index between 1-3 (potentially indicative of unstable reduction due to malrotation of the fragments, which can allow the development of a cubitus varus deformity).

**Conclusion:** From this radiographic review, a significant proportion of fractures treated with closed reduction and cast immobilization failed to achieve anatomic position and alignment on final x-rays. However, the clinical significance of these results and the potential for long-term re-modeling of these fractures remains unknown.
122 - Systematic Review of Rigid, Locked, Intramedullary Nail Insertion Sites and Avascular Necrosis of the Femoral Head in the Skeletally Immature
Joshua AM MacNeil, NS; Ronald El-Hawary, NS; Antony Francis, NS;

Purpose: Fractures of the femoral diaphysis are common injuries in the paediatric population. Rigid, locked, intramedullary nailing allows for early mobilization, but is usually reserved for older children and adolescents. Avascular necrosis (AVN) of the femoral head is a rare but serious complication of this technique. The entry site of the nail has been speculated to have an effect on this risk. Different nail entry sites have been used and include the piriformis fossa, tip of the greater trochanter, and the lateral greater trochanter. The purpose of this study is to complete a review of the literature to determine the effects of nail entry site on the risk of proximal femoral AVN.

Method: The English medical literature (PubMed, Embase, Cochrane database, and relevant articles from the bibliographies) was searched and 1277 articles were identified. Articles were excluded if they were case reports, if they did not examine long term complications, or if the insertion location could not be determined. Patients treated using each insertion site were combined together for analysis to determine the overall AVN and complication rate for each site.

Results: From the 1277 articles identified, 19 articles met the inclusion criteria. The piriformis fossa treatment group included 239 patients and had an AVN rate of 2%. The tip of the greater trochanter treatment group included 139 patients and had an AVN rate of 1.4%. The lateral greater trochanter treatment group included 80 patients and had no reported cases of AVN. Other complications included length discrepancy, heterotrophic ossification, and changes in proximal femoral morphology (articulat trochanteric distance, neck shaft angle, trochanter to trochanter distance, and femoral neck diameter).

Conclusion: Based on the current literature, the lateral greater trochanteric entry site for rigid, locked intramedullary nailing has a lower risk of AVN as compared to the piriformis fossa and the tip of the greater trochanter entry sites.

123 - A Randomised Controlled Trial of Cast versus Wrist Splint in Children with Acceptably Angulated Wrist Fractures
Andrew W Howard, ON; Andrew Willan, ON; Kathy Boutis, ON;

Purpose: Purpose: In skeletally immature children with acceptably angulated (≤ 15 degrees angular deformity at presentation) distal radius and/or ulnar fractures, to determine if a pre-fabricated wrist splint is at least as effective as a cast. The primary outcome was recovery of physical function six weeks after the injury as measured by the validated Activities Scale for Kids. Secondary objectives included determining differences in angulation of fracture, wrist range of motion, wrist strength, pain with movement, return to baseline activities, and patient preferences at six weeks.

Method: Methods: A randomized controlled, non-inferiority, single (evaluator) blinded, single-centre trial in a tertiary care pediatric emergency department. Minimal required sample size of 76 patients with was based on testing the null hypothesis (H0) that the brace is 7% less effective at the 2.5% level. Physical function was tested by a t-test for a non-zero difference. For the other outcomes, proportions and means were compared with the Fisher Exact and Student s t-test, respectively.

Results: Of the 100 randomized patients, 3 were excluded due to non-eligibility on radiographic review. 93 of the 97 completed full clinical, radiographic, and patient determined followup. ASK scores at six weeks were 92.8 in the splint group and 91.4 in the cast group, neither clinically nor statistically significantly different. Among patients treated in a cast, the average angular deformity at followup was 11.0 degrees and compared with an average of 6.6 degrees angulation among patients treated in a splint (p=.02, t-test). These groups were equal at baseline, with an average of 7.5 degrees of angulation in the cast group and 6.7 degrees in the splint group. Complications did not differ between groups, nor did range of motion with the exception that pronation was slightly better (84 versus 74 degrees) in the splint group at the end of treatment. No patient required any operative procedure. Parents preferred splinting over casting (p<0.001) and children preferred splinting over casting (p=0.028).

Conclusion: Conclusions: Splinting was non-inferior to casting, and in fact may be superior to casting, for maintaining the position of a minimally displaced distal radial metaphyseal fracture. Significance: The benefits of splinting over casting have been previously established for undisplaced distal radius and ulnar fractures (Plint), this is the first study which extends these benefits to the large group of children with minimally displaced distal radius fractures. Splint treatment simplifies care for children, reduces cost, and improves short term outcomes.

124 - Effect of Salter Pelvic Osteotomy on Acetabular Version
Sulamain Almousa, ON; Paul E Beaulé, ON;

Purpose: Iatrogenic acetabular retroversion is a known complication after pelvic osteotomy leading to persistent hip pain and increasing risk of subsequent osteoarthritis. The purpose of this study is to document the incidence of acetabular retroversion and signs of impingement in patients who have had a Salter pelvic osteotomy in childhood.

Method: Twenty eight patients (32 hips) had a Salter Osteotomy between 1980 and 1999, 16 were lost to follow-up. Of the 12 studied, eight had a diagnosis of DDH and four had Legg Calve Perthes. Clinical assessment for the presence of the impingement sign, range of motion and leg length discrepancy was done as well as functional scores. AP pelvic radiographs were taken to assess acetabular retroversion (cross-over or ischial sign), osteoarthritis using the Tonnis grade, center-edge and Tonnis angles.

Results: The mean age of the sample was 17.25 years (SD=7.27) with a mean follow-up of 10.56 years (SD=6.27). Impingement sign was positive in seven patients (58.3%). Nine out of the 12 had acetabular retroversion. Nine had Tonnis grade 1, two Tonnis grade 2,
and one had a Tonnis grade 3. Mean center edge and Tonnis angles were 26° (SD=16.43) and 9.09° (SD=6.49), respectively. There was no correlation between presence of acetabular retroversion with Tonnis grade (p=.700), hip pain (p=.317) or impingement sign (p=.621).

Conclusion: Retroversion is highly prevalent (69.2%) in patients who underwent a Salter pelvic osteotomy for a childhood hip disease. Although acetabular retroversion is a known cause of impingement in adulthood, our patient cohort was too small to detect a significant impact on the functional scores.

125 - Impact of Surgical Waitlist Times on Scoliosis Surgery: Surgeon’s Perspective
Renjit Varghese, BC; Firoz Miyanji, BC; Christopher W Reilly, BC; Suken Shah, US; Amer F Samdani, US; Peter O Newton, US; Kishore Mulpuri, BC;

Purpose: The wait for surgical treatment of scoliosis is long in some countries, especially in those with publicly funded health care systems. Long wait times may have serious consequences if the deformity increases during the wait period. This study was undertaken to determine the surgeon’s perspective of the type and magnitude of surgery required with specific emphasis on peri- and post-operative measures, for patients with scoliosis on prolonged waitlist times (>6 months) for surgery.

Method: Radiographs from 11 patients who had a Cobb angle of at least 50 degrees and had waited 6 or more months for scoliosis surgery selected from the scoliosis database. All patients had antero-posterior (AP), AP bending, and lateral radiographs taken when the primary curve magnitude was 50 degrees and at the time of pre-operative planning. 22 radiographic sets and a questionnaire were sent to three different surgeons. The surgeons were blinded to the fact that these sets contained films of the same patients at two different time points. The questionnaire requested information with regard to the type of surgery and instrumentation they would use, other peri-operative measures, and time taken to return to normal activities.

Results: The mean curve progression in the 11 patients was 25 degrees over the time on the waitlist, from an average of 50 degrees to 75 degrees. The type of surgery the surgeon would likely perform changed from posterior instrumentation and fusion with a screw construct in all patients to anterior release and posterior instrumentation and fusion with a screw construct in 8 of the 11 patients, in at least one surgeon’s opinion. The mean estimated operative time increased by 2 hours. The mean estimated length of stay at the hospital increased by 1 day, and the estimated level of difficulty of surgery increased from 3/10 to 5/10.

Conclusion: From a surgeon’s perspective, waits of 6 months or more for scoliosis surgery are unacceptable as they lead to the need for a second anterior procedure that probably would have not been necessary had the operation occurred earlier. It also leads to increased operative time, blood loss, length of stay, and difficulty of surgery. This, in turn, increases unwarranted risks and costs.

126 - Ambulation Gains After Knee Surgery in Children with Arthrogryposis
Stephen Yang, QC; Reggie Hamdy*, QC; Noemi Dahan-Oliel, QC;

Purpose: Arthrogryposis Multiplex Congenita is a rare congenital disorder associated with multiple musculoskeletal contractures which causes substantial morbidity. Knee involvement is commonly seen among children with arthrogryposis, with flexion contracture of the knee being the most frequent knee deformity. Knee flexion contractures in the paediatric population are particularly debilitating as they affect ambulation. Treatment for knee flexion contractures requires numerous orthopaedic procedures and an extensive follow-up period. The purpose of this study was to assess the effectiveness of orthopaedic procedures, namely distal femoral extension osteotomy and/or Ilizarov external fixator, on the ambulation status of children with knee flexion contracture.

Method: The medical records and radiological images of 16 paediatric patients with arthrogryposis and knee flexion contractures were reviewed. The etiology of all of them was amyoplasia except for one case of popliteal pterygium. The mean age of first surgery was 6.2 years (age range: 1-15 years). The mean length of follow-up was 83.9 months. All patients’ knee flexion contractures were treated with femoral extension osteotomy, Ilizarov external fixator, or both. Two patients previously had posterior soft tissue releases, including hamstrings lengthenings, proximal gastrocnemius release, and release of posterior capsule.

Results: Prior to the initial surgery for knee flexion contracture, 13 patients were non-ambulatory. One patient was a household ambulator with flexed knees. Two patients walked with orthoses. There was an average of 1.8 surgeries done per patient, namely distal femoral extension osteotomy and/or Ilizarov external fixator. At the latest follow-up, 12 patients were ambulatory, including 11 children ambulating with technical aids (orthosis, walker, braces, or rollator walker) and one child ambulating without any technical aid. Four patients remained non-ambulatory. The mean total arc of motion was 64.8 degrees preoperatively, 63.1 degrees postoperatively, and 52.8 degrees at the latest follow-up. A mean loss of 6.8 degrees per year in total arc of motion occurred. There were complications in four patients which consist of infected hardware, transient neurological compromise, cast change, and pressure sore.

Conclusion: Surgical correction of knee flexion deformities by distal femoral extension osteotomy and/or Ilizarov external fixator was effective in improving the ambulation status of children with arthrogryposis. At latest follow-up, the gradual loss of total arc of motion did not impact the ambulatory gains made by these procedures.

127 - A Low-power Wireless Data Acquisition System to Monitor Gait Patterns Among Toe-Walking Children During Daily Activities
Sultan Al-Dosari, AB; Sukhdeep K Dulai, AB; Edmond Lou, AB; John Andersen, AB; Joe Watt, AB; Kyle A Kemp, AB;

Purpose: Clinical gait analysis is considered the “gold standard” for evaluating individual walking patterns. However, in conditions where an individual may exhibit transient voluntary control of gait (such as idiopathic toe walking), their walking pattern in a gait lab may
not accurately reflect their gait during daily activities. An accurate assessment of such patients’ functional gait is essential in determining appropriate management options and response to treatment. Therefore, a battery-powered, wireless data acquisition system (WDAS) was developed to record daily functional walking patterns. The goal of the present study was to compare the tilt angle and load data obtained from the WDAS with those measured by gait lab equipment in a sample of healthy adult volunteers.

**Method:** Seven members of the research team participated in our validation study. Following informed consent, the WDAS was attached to the dorsum (laces) of each subject’s right shoe. Two thin film load sensors were wired to the device and placed under the sole of the foot, inside the shoe. Three spherical markers were placed on the same foot (head of first metatarsal, head of fifth metatarsal, calcaneous). Data were simultaneously recorded by the WDAS (30 Hz) and gait lab (60 Hz). To calibrate the device, each subject performed three static standing tasks (normal standing, weight bearing on toes, weight bearing on heels). Each subject then performed five normal walking trials and five toe-walking trials over a ten-metre, level course.

**Results:** From the WDAS and gait lab, the average percentage of time spent on the toes (load values under first toe greater than zero) during the stance phase of normal gait was 50.2% and 67.4%, respectively. During toe walking, this increased to 98.9% and 99.8%, respectively. This indicates that the WDAS and gait lab are similar in their ability to discern between normal and toe-walking gait. For the inclination angle, within-subject correlation values of $r = 0.76$ and $r = 0.92$ were observed during normal walking and toe walking, respectively. This indicates acceptable levels of agreement between the inclination measures of the WDAS and gait lab.

**Conclusion:** The validity of angle data from the WDAS was confirmed, when compared to data retrieved from a formal, gait analysis lab. Furthermore, the WDAS was able to clearly differentiate between a normal and a toe walking pattern. The WDAS may assist clinicians in the diagnosis and treatment of gait abnormalities, based on information retrieved during daily activities.

**128 - Comparison of Two Different Cast Materials for the Treatment of Congenital Idiopathic Clubfoot using the Ponseti Method: A Prospective Randomised Controlled Trial**

**Jason J Howard, NS; Catherine Hui, AB; Alberto Nettel-Aguirre, AB; Elaine Joughin*, AB; Simon Goldstein, AB; James Harder, AB; Gerhard Kiefer, AB; David Parsons, AB;**

**Purpose:** Congenital idiopathic clubfoot is the most common congenital deformity in children and can be a major cause of disability for the child as well as an emotional stress for the parents. The Ponseti method of clubfoot correction, consisting of serial manipulations and casting, is now the gold standard of treatment. It has traditionally been described using plaster of Paris (POP) above-knee casts, which are affordable, stiff, and easily moldable. Recently, semi-rigid fiberglass softcast (FSC, 3M Scotchcast) has grown in popularity due to ease of removal, durability, lighter weight, better appearance, ease of cleaning, and water resistance. There are currently no randomized controlled trials to prove its efficacy with respect to POP. The purpose of this study was to determine the influence of choice of cast material on the correction of congenital idiopathic clubfeet using the Ponseti method.

**Method:** A prospective, randomized controlled trial. Based on the results of a pilot study performed at our centre, a sample size of 30 patients was determined to be appropriate. Thirty consecutive patients presenting with congenital idiopathic clubfoot were randomized into POP and FSC groups prior to commencement of treatment with the Ponseti Method. Clubfeet secondary to non-idiopathic diagnoses were excluded. The Pirani classification was used to determine clubfoot severity (less severe, <=4; severe >4), and for surveillance during casting. The primary outcome measure was the number of casts required to correct the clubfoot deformities to the point where the foot was ready for a percutaneous tendo-achilles tenotomy (TAL) or when the foot was completely corrected (Pirani=0). Secondary outcome measures include: number of casts by clubfoot severity, ease of cast removal, number of methods needed to remove casts, need for percutaneous tendo-achilles tenotomy.

**Results:** Of the 30 patients enrolled, 13 (40%) were randomized to POP and 18 (60%) to FSC. No patients were lost to follow-up. In the POP and FSC groups, eight (67%) and 11 patients (61%) underwent a TAL, respectively. In general, there were no differences in the mean number of casts required for clubfoot correction between the two groups (p=0.13). When analyzed by clubfoot severity, the mean number of casts for each material in the less severe group was equal (3 casts). In the severe group, the mean number of casts in the FSC group (6.4 casts) was considerably higher than for the POP group (4.7 casts) but our study was underpowered to verify this result. According to parents, POP was harder to remove than FSC (p<0.001).

**Conclusion:** In general, FSC was found to be as efficacious as POP in the correction of idiopathic clubfeet by the Ponseti Method and was the preferred cast material by parents. For stiffer, more severe feet, POP seemed to show a faster correction time than FSC.

**Paper Session #14 COA Sports Knee/Hip/Shoulder**

**129 - Accuracy of Meniscal Lesion Evaluation in an ACL Injured Joint**

**Jason Peeler, MB; Jeffrey Leiter, MB; Peter B MacDonald, MB;**

**Purpose:** This research project compared the accuracy of 3 methods of meniscal injury diagnosis that are commonly employed in a clinical orthopaedics: Clinical examination, MRI and Arthroscopic surgery.

**Method:** A retrospective review of charting was used to collect meniscal injury assessment data for 116 patients that had sustained an acute anterior cruciate ligament injury to one knee. Sixty-eight of the 116 patients had the presence of a meniscal lesion confirmed via surgery. Sensitivity and specificity of “hands on” clinical examination and MRI interpretation were determined using the results of
arthroscopic surgery as the gold standard. Sensitivity and specificity of “hands on” clinical examination relative to MRI interpretation was also calculated. Finally, the findings of all three methods of meniscal evaluation were compared.

**Results:** Accuracy testing demonstrated that the sensitivity and specificity of clinical examinations (0.54 / 0.81) was comparable to levels observed for MRI (0.69 / 0.70), and when directly comparing the findings of clinical examination against MRI, that there was a high level of agreement when a meniscal lesion was not present (specificity: 0.91), but a much lower level of agreement when a meniscal lesion was suspected (sensitivity: 0.54). In general, when comparing the findings from clinical examination, MRI, and arthroscopic surgery, complete agreement among all 3 methods of evaluation occurred in only 51% of the patients.

**Conclusion:** Our results serve to highlight the inaccuracies associated with meniscal injury assessment when evaluating an acutely traumatized knee joint, and suggest that the incidence of secondary joint trauma following ligament injury may be under predicted.

**130 - Prospective Randomised Trial of Ipsilateral versus Contralateral Hamstring Graft in ACL Reconstruction**

Peter B MacDonald, MB; Robert McCormack, BC; Sheila McRae, MB; Jeffrey Leiter, MB; Mauri Zomar, BC; Jason Old, MB; Scott Wiens, AB;

**Purpose:** The hypothesis of this randomized controlled trial is patients undergoing ACL reconstruction using contralateral hamstring harvest will have better quality of life and strength than using ipsilateral graft.

**Method:** One hundred participants were assigned to the ipsilateral (IG) or contralateral (CG) group. Primary and secondary outcomes were ACL Quality of Life (ACL-QOL) and concentric isovelocity knee flexion/extension strength measured on a dynamometer at five speeds. Data was gathered pre-surgery, and at 3, 6, 12, and 24 months post-surgery. Findings to 12 months are presented.

**Results:** ACL-QOL scores and knee flexion/extension strength were not significantly different between groups across time. Comparing side-to-side within each group, knee extension strength was consistently higher on the non-reconstructed side. In the IG, there were no side-to-side differences in knee flexion strength. In the CG, flexion on the reconstructed side was stronger than the grafted side early post surgery (3, 6 months) at 60 degrees/s, but this pattern was reversed at 90, 150, and 210 degrees/s. Post-hoc comparisons revealed hamstring/quadriceps (H/Q) ratios were not different between limbs in the CG or for the uninvolved limb for the IG. However, at most time points and speeds, the H/Q ratio for the involved limb in the IG was higher than the uninvolved limb in the IG and either limb in the CG.

**Conclusion:** This study reveals that ipsilateral graft harvest may alter the H/Q ratio. It was also demonstrated that contralateral graft harvest may normalize this effect. This may have some bearing on function and re-injury risk that should be further investigated.

**131 - Iliac Crest Allograft for Recurrent Anterior Shoulder Instability in Athletes**

Randy Mascarenhas, MB; Eden Raleigh, AU; Sheila McRae, MB; Jeffrey Leiter, MB; Peter B MacDonald, MB;

**Purpose:** Performing a labral repair alone in patients with recurrent anterior instability and a large glenoid defect has led to poor outcomes. We present a technique involving the use of iliac crest allograft inserted into the glenoid defect in athletes with recurrent anterior shoulder instability and large bony defects of the glenoid (>25% of glenoid diameter) We hypothesized that restoring a near-normal glenoid structure would prevent further dislocations and that osseous union would be achieved

**Method:** All athletes with recurrent anterior shoulder instability and a large glenoid defect who underwent open anterior shoulder stabilization and glenoid reconstruction with iliac crest allograft were prospectively followed over a three year period. Pre-operatively, a detailed history and physical exam was obtained along with radiographs, a CT scan, and magnetic resonance imaging of the affected shoulder. All patients also complete the Simple Shoulder Test (SST) and American Shoulder and Elbow Surgeons (ASES) evaluation forms pre- and post-operatively. A CT scan was again obtained 6 months post-operatively to assess osseous union of the graft, and the patient again when through a physical exam in addition to completing the SST, ASES, and Western Ontario Shoulder Instability Index (WOSI) forms.

**Results:** Nine patients (all male) were followed for an average of 16 months (4 – 36 months) and had a mean age of 24.4 years. All patients exhibited a negative apprehension/ relocation test and full shoulder strength at final follow-up. Eight of nine patients had achieved osseous union at six months (88.9%). ASES scores improved from 64.3 to 96.7, and SST scores improved from 66.7 to 100. Average post-operative WOSI scores were 94%.

**Conclusion:** The use of iliac crest allograft provides a safe and clinically useful alternative compared to previously described procedures for recurrent shoulder instability in the face of glenoid deficiency

**132 - Long-term Survival of High Tibial Osteotomy for Medial Osteoarthritis of the Knee**

Catherine Hui, AU; Lucy Salmon, AU; Alison Kok, AU; Shinichi Maeno, AU; Leo Pinczewski, AU;

**Purpose:** The management of degenerative arthritis of the knee in the younger, active patient often presents a challenge to the orthopaedic surgeon. Surgical treatment options include: high tibial osteotomy (HTO), unicompartmental knee arthroplasty (UKA) and total knee arthroplasty (TKA). The purpose of this study was to examine the long-term survival of closing wedge HTO in a large series of patients 8-19 years after surgery.

**Method:** The results of 458 consecutive patients undergoing lateral closing wedge HTO for medial compartment osteoarthritis (MCOA) between 1990 and 2001 were reviewed. Between 2008-2009, patients were contacted via telephone and assessment included: incidence of further surgery, Oxford Knee Score, and British Orthopaedic Association (BOA) Patient Satisfaction Scale. Failure was defined as the need for revision HTO or conversion to UKA or TKA. Survival analysis was completed using the Kaplan-Meier method.
Results: We were able to contact 400/458 (87%) patients for follow-up via telephone interview. Five patients (1%) who declined participation were excluded. Fifty-eight patients (13%) were lost to follow-up. Of the 395 patients, 12 (3%) had died of unrelated causes and 124 (31%) required further knee surgery. The remaining 259 (66%) completed the BOA patient satisfaction score and Oxford Knee Score. The probability of survival for HTO at 5, 10 and 15 years was 95%, 79% and 55% respectively. Multivariate regression analysis showed that only age < 50 years (p<0.001) was associated with significantly longer survival. Mean Oxford Knee Score was 40/48 (range 17-60). Ninety-two percent (239/259 patients) were enthusiastic or satisfied and 90% (234/259 patients) would undergo HTO again at mean 11 years follow-up. Complications included: 5 pulmonary embolisms, 8 deep vein thromboses, 1 non-union, 1 post-operative subarachnoid hemorrhage and 1 transient peroneal nerve palsy.

Conclusion: To our knowledge, we have reported the long-term follow-up of lateral closing wedge HTO in the largest group of patients in the literature. We found that the results of HTO do deteriorate over time but that HTO can be effective for as long as 19 years. In appropriately selected patients and circumstances, HTO gives high patient satisfaction and affords patients unrestricted activity for many years.

133 - The Role of Hip Arthroscopy in Synovial Chondromatosis: 1 to 10 Year Follow-up of 29 Patients

Purpose: Synovial chondromatosis is a cartilaginous metaplasia that can result in multiple intracapsular and extracapsular loose bodies. Open arthrotomy has been the conventional treatment for this condition in the hip, but is associated with neurovascular embarrassment and femoral head osteonecrosis. Hip arthroscopy avoids these problems, and is a minimally invasive approach to diagnosis and treatment. Our aim was to evaluate the role of arthroscopy in the management of synovial chondromatosis of the hip at the early-to-intermediate stages of disease.

Method: Twenty-nine patients had arthroscopic treatment for synovial chondromatosis of the hip. All lesions were intracapsular and smaller than 10mm. Radiographs of the painful hip, computed tomography, and gadolinium-enhanced magnetic resonance imaging were obtained pre-operatively. During arthroscopy, loose bodies were removed via a cannula, and partial synovectomy, partial labrectomy, chondroplasty, and microfracture were done as needed.

Results: Fourteen patients were women and 15 were men; mean age was 41 years old; mean duration of symptoms was 52 months. All patients had hip pain. Mechanical hip symptoms were reported by 63% of patients. Twenty-three patients had a follow-up of at least 12 months (12 to 184 months of follow-up). Loose bodies could be seen in the imaging studies of 58% (15 of 29) of patients: 8 on radiographs and 7 with computed tomography or gadolinium-enhanced magnetic resonance imaging. At surgery, 23 of the 29 patients had torn or frayed labra. There was an average of 35 loose bodies per patient. Twenty-three of the 29 patients had femoral head changes, four of which had Grade III or IV lesions. Twenty-five of the 29 had acetabular chondral findings, ten of which had Grade III or IV lesions. Five of the 29 patients eventually underwent total hip reconstruction surgery at an average of 52 months follow-up; four of these 5 patients had at least a Grade III lesion at the time of arthroscopy. Eleven of the 23 patients who had a minimum of 12 months follow-up (12 to 184 months) had good to excellent outcomes at an average of 60 months follow-up. Complications included a case of perineal numbness and another with tingling of the foot.

Conclusion: Our patients with synovial chondromatosis of the hip benefited from hip arthroscopy. Imaging studies alone, including gadolinium-enhanced MRI, failed to establish the diagnosis in half of the patients. Diagnosis was eventually made by direct visualization of the loose bodies via arthroscopy. None of our patients had subsequent femoral head osteonecrosis or infection. For patients who had Grade I or II cartilage lesions, early diagnosis and treatment via arthroscopy helped prevent or delay the onset of secondary osteoarthritis. Arthroscopy also avoided an open surgical exposure with its associated prolonged rehabilitation. It is a valid and effective treatment for early-to-intermediate stages of synovial chondromatosis.

134 - A Solution to Focal Medial Compartment Osteoarthritis of the Knee in the Young Patient: The UNICAP Knee Resurfacing
Shalinder S Arneja, BC; Morgan Jones, US; Anthony Miniaci, US;

Purpose: Historically, there have been few surgical options for patients with focal full-thickness cartilage lesions in the knee who have failed or are too advanced in age for biologic resurfacing treatments, yet are also relatively too young or unwilling to undergo conventional total or unicompartmental knee arthroplasty. The UniCap knee resurfacing arthroplasty provides an option for these patients that is minimally invasive, preserves the menisci and cruciate ligaments, and retains the bony architecture of the knee joint, thereby providing the potential for a rapid recovery to more vigorous activities than might be permitted after conventional knee arthroplasty, while preserving range of motion. The objective of this study was to examine the clinical results of a patient cohort undergoing the UniCAP knee resurfacing in the medial compartment of the knee.

Method: Prospective patients were screened with history and clinical examination, weight-bearing radiographs, and MRI. Patients were offered UniCap knee resurfacing arthroplasty if they had symptomatic full-thickness cartilage lesions in the medial and/or patellofemoral compartments. The cohort included 38 cases in 35 patients who underwent the UniCAP knee resurfacing procedure in the knee with focal medial compartment (with or without patellofemoral) osteoarthritis in the knee joint. In addition, patients were assessed with validated and established outcome scales including the International Knee Documentation Committee Subjective Form, the Knee Injury and Osteoarthritis Outcome Scale, which includes the WOMAC Osteoarthritis Index.

Results: The average age of patients undergoing knee resurfacing was 48.25 years (Range: 23 to 80). There were 24 males and 12 females. Thirty-one patients underwent isolated medial compartment resurfacing and 7 patients received both a medial compartment resurfacing and trochlear resurfacing. Three patients underwent a concomitant ACL reconstruction and 1 patient underwent a...
concomitant high tibial osteotomy. The mean duration of follow up was 18 months (Range: 12 to 26 months). There was an overall mean improvement from the pre-operative to post-operative scores in the IKDS-SF (P < 0.01), KOOS (all domains, P < 0.01) and WOMAC Index (P < 0.01). There were no major complications such as deep infection, DVT, or implant failure. In addition, there was no evidence of mechanical symptoms/signs or radiographic evidence of loosening at any time point post-operatively.

**Conclusion:** The short-term results demonstrate that the UniCAP resurfacing arthroplasty in the knee is a viable treatment option for focal full thickness cartilage lesions in the medial compartment of the knee in patients who are no longer candidates for biologic resurfacing procedures and who are also relatively too young or unwilling to undergo conventional total or unicompartmental knee arthroplasty.

### 135 - Depth-wise Measurement of Subchondral Bone Characteristics-Implications for Microfracture Surgery

**Mark Hurtig, ON; Mark Lowerison, ON; Paul Marks, ON;**

**Purpose:** 1) To develop a method for depth-wise analysis of subchondral bone that considers the gradient of bone volume, density and organization between the articular surface and the marrow cavity. 2) To understand the interplay between subchondral bone changes and extrinsic cartilage repair after microfracture.

**Method:** Since 30% of patients fail microfracture for contained cartilage lesions, our hypothesis was that early subchondral sclerosis increases compaction of bone around microfracture holes, leading to failed cartilage repair. Human osteochondral segments from the knee joint were characterized macroscopically using the Outerbridge score, then imaged at 45 micron resolution using microCT. Regions of interest (ROI) were chosen under normal cartilage and abnormal cartilage (Outerbridge Score=1). Routine Bone mineral density (BMD) analysis was performed on each ROI using GE MicroView™ analysis software. Additional depth-wise analysis of BMD was done by exporting each ROI as a density map, and calculating the mean, standard deviation and rate of change of BMD by slice in the vertical (coronal) plane. Plots of normal and early OA data by depth were compared. Microfracture holes were made in normal and sclerotic subchondral bone, and depthwise measurements of subchondral compaction around the holes were made were made.

**Results:** Bone under normal versus OA cartilage was very subtly different in microCT images, but ROI microCT analysis showed that the OA samples were more mineralized and contained more bone. Using the depth-wise analysis algorithm, automated detection and measurement of the subchondral bone plate and other discrete structures was possible. The depth-wise analysis confirmed that the osteoarthritic subchondral bone plate had a higher BMD and bone volume fraction, but also showed that the rate of change (gradient) in BMD was greater. Horizontally orientated trabeculae and other anomalies were found in OA bone that contributed a more variable BMD in trabecular bone at up to 5 mm from the articular surface. Bone with early sclerotic changes had significantly (p<0.01) more bone volume fraction and BMD (p<.05) around microfracture holes in this ex vivo experiment.

**Conclusion:** An enhanced picture of subchondral bone plate and trabecular bone anomalies can be appreciated using a depth-wise approach to image analysis. Both sclerosis and osteopenia have been reported in OA and models of OA, but this analysis shows that variability and gradient of BMD change adjacent to the articular cartilage is a significant feature of OA. This is consistent with some theories of OA progression that implicate stress concentration between the cartilage and subchondral bone plate leading to cartilage degeneration. More importantly, bone sclerosis has a direct effect on the amount of compaction around microfracture holes, so improvements in microfracture technique are needed to avoid this.

### 136 - Graft Choice in Medial Opening Wedge High Tibial Osteotomy: Auto vs Allograft.

**Bashar Alolabi, ON; Bryant Dianne, ON; Peter J Fowler, ON; Kevin Willits, ON; J Robert Giffin, ON;**

**Purpose:** Medial opening wedge high tibial osteotomy (MOW-HTO) is a well-described operative method for the treatment of medial gonarthrosis in selected patients. One of the concerns with MOW-HTO is the potential delayed or nonunion across the medial gap. Traditionally, this gap was filled with autograft to facilitate union. Although alternative graft options, such as allograft, are available and have theoretical advantages over autograft, little is known about their efficacy relative to autograft in MOW-HTO. The purpose of our study was to perform a retrospective matched cohort study comparing union, re-operation and complication rates between autograft and morselized allograft as filler for the medial gap created in MOW-HTO.

**Method:** Forty patients who underwent MOW-HTO for sympathetic varus deformity with the use of autograft bone were matched for age, sex, body mass index, deformity and deformity correction with 40 patients who underwent the same procedure with the use of morselized bone allograft. The operative technique utilized, type of hardware fixation and rehabilitation program were similar for both groups. The primary outcome assessed was union rate as evaluated on radiographs by two independent blinded examiners. Re-operation and complication rates were assessed as secondary outcomes.

**Results:** A total of 73/80 patients in the study (91%) developed union, 4/80 (5%) developed nonunion, and 3/80 (4%) required early revision. The union rate was 95% and 88% in the autograft and allograft groups respectively. Three percent in the autograft and 8% in the allograft groups developed nonunion (p=0.64). Thirteen percent of the autograft patients required re-operation compared to 18% from the allograft patients (p=0.53). Complications were encountered in 28% of the autograft group and in 23% of the allograft group (p >0.05). There was a 10% incidence of harvest site complications in the autograft group. The average operative time was 21 minutes shorter using allograft compared with using autograft (p<0.01).

**Conclusion:** No statistical significant difference was demonstrated between the groups for union, re-operation rates and overall complication rates. However, the autograft group had a significant 10% incidence of harvest site complications and a statistically significant increased operative time. We conclude that allograft is safe and efficacious to use in valgus producing MOW-HTO. Allograft avoids harvest site complications and is associated with decreased operative time when compared to autograft.
137 - A Prospective Randomised Study of the Effect of Skin Incision Angle on Infrapatellar Neuritis and Altered Skin Sensation in Anterior Cruciate Ligament Reconstructions with Semitendinosus/Gracilis Tendon Grafts

Peter B MacDonald, MB; Jeffrey Leiter, MB; Sheila McRae, MB; Alan Hammond, MB;

Purpose: Damage to the infrapatellar branch of the saphenous nerve and subsequent loss of sensation following graft harvest in ACL reconstruction is common. An oblique incision, rather than a vertical incision, has been shown to reduce the incidence and area of sensory loss following graft harvest [1] although the results are not universal. The purpose of this study was to determine if there was a difference in the area of infrapatellar neuritis (IFPN) and quality of life (QOL) between ACL patients that received a vertical- (VI) versus oblique-incision (OI) for hamstring tendon harvest.

Method: An interim analysis of a single-blinded randomized controlled trial (N=100) was conducted. Patients with clinical- and/or MRI-evidence of an ACL tear and no previous injury to the knee or surrounding soft tissues (including skin) were consented. Participants completed an ACL-QOL questionnaire pre-operatively, were randomized intra-operatively, and returned for follow-up at 1.5-, 6-, 12- and 24-months to trace altered area of skin sensation and complete an ACL-QOL questionnaire. The area of altered skin sensation was quantified with ImageJ (NIH) software. The intention-to-treat principle was applied and a student's t-test was used for statistical analysis. (p<.05).

Results: An interim analysis of 25 patients with a follow-up of 6- to 24-mo demonstrated that the VI group (79.1 ± 15.6 cm2) had a greater affected area than the OI group (10.9 ± 3.5 cm2), no difference in ACL-QOL scores was evident.

Conclusion: Based on the difference in morbidity between the two groups, and similar results in a previous study (2), OI incision for graft harvest is recommended.

138 - Prospective Clinical and Radiographic Intermediate Outcomes of Fresh Talar Allografts for Large Osteochondral Talar Lesions

Timothy R Daniels, ON; Roger Haene, ON; Rob Story, AU; Ellie Pinsker, ON;

Purpose: The treatment of large osteochondral lesions of the talus (OLT) remains a challenge. Fresh Osteochondral Allograft is a method that has been used for the treatment of larger lesions, with the advantage of transplanting living cartilage that is biologically attached to the subchondral bone. The purpose of this clinical series is to prospectively review the clinical and radiographic outcomes of patients that have undergone a Fresh Osteochondral Allograft.

Method: Between January 2003 and January 2007, 17 feet in 8 male and 8 female patients at a mean age of 35.8 (15-53) years underwent fresh osteochondral talal allografting by a single surgeon. Data was prospectively collected, including preoperative and postoperative AOFAS, AOS, AAOS foot & ankle worksheets and SF-36 scores. Statistical analysis consisted of one tailed student T-test with alpha set a 5%. All patients were followed up clinically and radiographically by x-ray and CT scan.

Results: Average follow up was 3.2 (0.9-6.2) years. All scoring systems showed significant improvement postoperatively, except for AASO shoe comfort scores, and the Mental Component Summary of the SF-36 questionnaire. The AOFAS score improved significantly (p=0.0001) from a mean score of 53.4 (30-71) to 86.3 (72-96). AOS pain scores improved significantly (p=0.0053) from a mean score of 45.4 (8.7-72.2) to 24.1 (4.2-58.9). AOS disability score improved significantly (p=0.0013) from a mean of 53.8 (7.8-77.3) to 25.9 (6.6 - 62.5). The AAOS foot & ankle core scale (standardized mean) improved significantly (p=0.0015) from a mean of 52.3 (21-81) to 80.1 (56-99). The AAOS foot & ankle core scale (normative score) improved significantly (p=0.0016) from a mean of 16.9 (-9 to 40) to 39.5 (20-55). The SF-36 Physical Component Summary improved significantly from a mean of 34.9 (24.2-43.8) to 47.3 (36.6-59.8). There was successful osseous graft incorporation in 16/17 feet (94%) verified on CT scan. Of the 16 grafts which had successfully incorporated, radiographic follow up showed 4/16 feet (25%) had signs of progressive OA and 3/16 feet (19%) had developed new osteolysis around the graft.

Conclusion: Although patients' functional outcome can be substantially improved with the use of fresh osteochondral allografts the early radiographic findings are of concern with 43% demonstrating progression of arthritis or osteolysis of the graft during the process of graft incorporation.

Paper Session #15 COA Trauma

139 - Outcome Assessment in Orthopaedic Trials: Is it Good Enough?

Nicole Simunovic, ON; Sheila Sprague, ON; Gordon H Guyatt, ON; PJ Devereaux, ON; Stephen D Walter, ON; Emil H Schemitsch, ON; Mohit Bhandari, ON;

Purpose: Unbiased outcome assessment in orthopedic clinical trials has the potential to improve trial validity. The approaches used to limit bias in outcome assessment in orthopaedic trials remain unclear. The objective of this systematic review was to assess the reporting and process of outcomes assessment practices in the current orthopaedic trauma literature.

Method: We searched eight high-impact-factor medical and orthopaedic journals manually and using the MEDLINE electronic database for reports of randomized controlled trials published from 2005 to 2008 pertaining to the surgical treatment of trauma-related injuries. Two reviewers independently determined study eligibility and extracted relevant data from included trials.
Results: Of the 7910 citations identified during our search, 47 randomized controlled trials, which included a total of 4706 patients, met our inclusion criteria. Of 47 studies, 39 (83%) provided a statement to describe some process of outcome assessment and 29 (74%) reported using an unblinded individual as the outcome adjudicator. Four studies (10%) reported using a second assessor to verify outcome measurements, and three studies (8%) reported the use of an adjudication committee to reach endpoint decisions via consensus. No included study provided a rationale for the use of their chosen approach to adjudication. The most commonly adjudicated outcomes included fracture healing (15 studies), reoperation rate (6 studies), and general clinical assessment of post-operative complications and limb function (30 studies), mainly by orthopaedic surgeons. Blinding of outcome assessors was not performed or unclear in 38 studies (81%).

Conclusion: Despite the importance of the outcome assessment process in orthopedic trauma trials, key aspects of outcome assessment are insufficiently reported. This limits the ability of readers to assess the validity of published trials.

140 - Approach-Withdraw Technique of Intra-operative Fluoroscopy to Avoid Intra-articular Screw Penetration with Proximal Humerus Locking Plates
George L Xenoyannis, ON; Jeff Yach, ON;

Purpose: Intra-articular screw penetration with the use of proximal humeral locking plates has a reported incidence in the literature of up 25%. It may occur early, due to an intra-operative unrecognized technical error, or as a result of late fracture collapse. This study was designed to demonstrate the "approach-withdraw" technique of intra-operative fluoroscopy which can be used to minimize the rate of early unrecognized intra-articular screw penetration.

Method: A radiographic review was undertaken of 37 patients with proximal humerus fractures fixed with either the PHILOS plate (Synthes, Westchester, Pennsylvania) or the Periocl proximal humerus plate (Smith and Nephew, Memphis, TN) by the senior author (JY) between 2002 and 2009. Intra-operative fluoroscopy was used in each case to ensure there was no intra-articular screw encroachment by visualizing each screw tip approach and then withdraw from the articular surface during live fluoroscopy as the shoulder was taken through a range of motion. Patients were then followed for an average of nine months with serial radiographs for post-operative intra-articular screw penetration, screw loosening, and maintenance of reduction. Maintenance of reduction was evaluated using the change in neck shaft angle and greater tuberosity to humeral height difference on the initial post-operative x-rays as compared to the x-rays at final follow-up.

Results: An average of six screws (range three to nine) was placed into the humeral head per patient. There was no incidence of intra-articular screw penetration on immediate post-operative radiographs. One patient had loss of reduction with a single screw breaching the subchondral bone and four screws loosening after a fall in the early postoperative period. The remainder of patients had no evidence of intra-articular screw penetration or screw loosening at last follow-up. One patient developed a non-union and had a subsequent reconstruction. The average change in neck shaft angle was four degrees (range 0° to 16°) and greater tuberosity to humeral head height difference was 1.9 mm (range 0 – 8.9).

Conclusion: The approach-withdraw technique is a useful intra-operative fluoroscopic test which may be utilized in the fixation of proximal humerus fractures to avoid unrecognized intra-operative screw penetration of the glenohumeral joint.

141 - Assessment of Patient Satisfaction with the Day Surgery Program at the Royal University Hospital in Saskatoon, Saskatchewan
Johannes M Van der Merwe, SK; R. Cole Beavis, SK; Geoffrey Johnston, SK;

Purpose: Due to bed and resource constraints at the Royal University Hospital in Saskatoon, Saskatchewan, we have seen an increase in utilization of the day surgery program for acute Orthopedic traumatic injuries in ambulatory patients. The purpose of this study was to assess patient satisfaction with the Saskatoon Health Region Orthopedic trauma day surgery program by collecting data pertaining to wait-times, demographics, communication, coping skills at home and pain management.

Method: A patient-oriented questionnaire was devised and administered to eligible adult patients presenting for day surgery Orthopedic Trauma procedures over a three month period. Inclusion criteria included age greater than 18 and written english comprehension. Between July 12 and October 2, 2009, 45 patients consented to participate. The questionnaire was formulated to encapsulate all the potential concerns associated with the day-surgery program, which included expected wait-times, pain control, and communication between the orthopedic surgeon and the patient. Demographics and actual wait-times were obtained from hospital data.

Results: There was a marked discrepancy between the actual and anticipated waiting times for day surgery. However, 64% of the patients were still satisfied with the waiting times despite the difference. Seventy three percent of patients did not think that admission to hospital would lead to earlier surgery. There was an obvious difference in demographics with 53% of patients living outside city limits. Demographics played an important role in patient satisfaction. Patients living within the city limits had a better experience compared to patients living outside city limits. Patients did have difficulty managing at home. The overall satisfaction was 68% at the conclusion of the study.

Conclusion: Patients were overall satisfied with the day surgery program. We have identified several areas where we can improve. This involve better pain management, better communication and assessment of the bio-socio-economic circumstances of patients. We will also have a lower threshold for admitting non residents of Saskatoon. We will relay a more realistic timeframe for surgery, as calculated in the study, to patients.
142 - The Impact of Clinical Data on the Evaluation of Tibial Fracture Healing
Mohit Bhandari, ON; Bernadette G Dijkman, ON; Jason W Busse, ON; Stephen D Walter, ON;

Purpose: Radiographic healing is a common outcome measure in orthopaedic trials and adjudication by outcome assessors is often conducted using only plain radiographs. We explored the effect of adding clinical notes to radiographs in the adjudication process of a pilot trial of tibial shaft fractures.

Method: Radiographic and clinical data from a multicenter clinical trial of 51 patients with operatively treated tibial fractures formed the basis of the study data. An independent adjudication committee of three blinded orthopaedic trauma surgeons evaluated radiographs for time to fracture healing. This committee then evaluated clinical notes associated with each radiographic follow up visit and were asked to either revise or maintain their initial impression. We calculated the proportion of time to healing consensus decisions that changed after evaluation of clinical notes. We further examined the contents of the clinical notes and its relative influence on the committee’s decisions.

Results: Forty-seven of 51 patients were determined to have radiographic evidence of healing during the trial follow-up period, and consideration of the clinical notes resulted in a change of 40% (19 of 47) of time to healing consensus decisions; however, revised decisions were equally likely to support an earlier or a later time to healing.

Conclusion: Addition of clinical notes changed the adjudication committee’s decision of radiographic fracture healing in a substantial number of cases. Our findings suggest that orthopedic trialists should consider the addition of clinical notes to adjudication material in studies of fracture healing.

143 - The Mechanical Effect of Locking and Blocking Screws in Distal Femur Fractures
David W Sanders, Ontario; Sagar Desai, ON; Louis M Ferreira, ON; Joshua W Giles, ON; James Johnson, ON;

Purpose: Blocking screws placed adjacent to intramedullary nails supplement fixation in long bone fractures with a short proximal or distal segment. Clinically, blocking screws are placed using fluoroscopy, resulting in variability in screw placement. The clinical significance of the accuracy of screw placement is unknown. Recently, a targeted locking screw device was developed, enabling precise placement of screws adjacent to the nail. The purpose of this study was to evaluate the mechanical effects of locking screws (LS) and targeted (TBS) and non-targeted blocking screws (NBS) in distal femur fractures.

Method: Sawbone® femurs were used to create a fracture model. Femoral sawbone specimens were osteotomized eight cm proximal to the knee joint and a two cm gap was created. Intramedullary nails were used for stabilization, including one proximal locking screw and varying the distal screw configuration for study purposes. Targeted locking screws were inserted directly adjacent to the intramedullary device using the commercially-available targeting device. Non-targeted screws were inserted one screw diameter medial or lateral to the “ideal” position. Four study groups were created; group one consisted of TBS and two distal LS. Group two had TBS and one LS. Group three had NBS and two LS, and group four consisted of NBS and one LS. Specimens were subjected to a cyclic compression protocol along the mechanical axis of the femur. Applied load varied from 100 to 700 N in 100 N incremental stages. Targeted constructs were stiffer at all load levels, and 10% stiffer overall. Differences were statistically significant at moderate load levels (Group one vs three, 400N and 500N, p<0.05).

Conclusion: Targeted constructs were stiffer at all load levels despite Sawbones® undergoing significant deformation at the proximal femur, masking the relatively smaller differences in motion at the fracture site. A difference in sagittal motion was found between groups with one and two LS, independent of the position of blocking screws. In conclusion, targeted blocking screw constructs were stiffer at all load levels compared to non-targeted constructs. The number of LS was a factor in sagittal plane stability. This study suggests that using targeted blocking screws in distal femur fractures may reduce fracture motion and decrease post operative malalignment.

144 - Is Angulation on the Lateral Hip Radiograph Related to Fracture Instability? A Retrospective Radiographic Review of 31-A2 Intertrochanteric Fractures
Tudor V Tufescu, MB; Bryn Sharkey, MB;

Purpose: The purpose of this study is to provide an additional tool to determine the stability of AO 31A2 pertrochanteric hip fractures. This study is based on the lateral hip radiograph, which has been ignored in the current debate over stability.

Method: One-hundred and thirty-one patients were identified through medical records with a diagnosis of pertrochanteric hip fracture treated with sliding hip screw from 2003-2008. Thirty-nine patients had AO 31A2 hip fractures, cross-table lateral injury films, intra-operative fluoroscopy and follow-up films. Only 23 had follow-up films beyond discharge. The landmarks of interest were angulation and translation between the femoral shaft and neck on cross-table lateral injury films. The neck was defined in three ways: the anterior cortex, two key points in the anterior cortex and the neck bisector. The most consistent measure was used. Translation of the neck was measured as a percentage of the shaft diameter. Measurements were taken by two blinded researchers with different levels of experience. Film sequence was randomized. The primary outcome was shortening of the sliding hip screw greater than one centimetre. This is the exact midpoint between 0.61 centimetres, which is not associated with reduced patient mobility, and 1.34 centimetres which is associated with reduced patient mobility, as described by Muller-Farber. The hip screw was measured from its tip to the point it enters the barrel. The diameter of the hip screw was known and provided scale. The measurement from intra-operative fluoroscopy films with the leg in traction, represented zero shortening.
**Results:** The average follow up was 190 days. Using the neck bisector to measure angulation was most consistent (95% of measurements available versus 89% and 88% with other methods). More than 30° angulation and/or 30° translation on the lateral predicted shortening greater than one centimetre with 91% specificity and 33% sensitivity. The average shortening in this group was 1.6 centimeters, which is greater than shortening associated with reduced patient mobility (1.34 centimeters). Agreement between two researchers was 91% and considered “substantial” (kappa 0.71) as per Landis and Koch criteria.

**Conclusion:** This is a highly specific and reproducible tool to detect a subset of AO 31A2 hip fractures which acquire unwanted collapse if treated with a sliding hip screw. This information adds clarity to the debate over stability of some AO 31A2 fracture cases, at no additional cost for the surgeon and facility. The “30/30 rule” (30° angulation and 30% translation) should not be used in isolation due to low sensitivity. Other factors may affect shortening, such as the degree of comminution and the antero-posterior film should still be considered.

**Reference:**

145 - Reamed versus Nonreamed Intramedullary Nailing of Femoral Diaphyseal Fractures: A Systematic Review and Meta-analysis

**Krista Goulding,** ON; **Rudolf Poolman,** NL; **Emil H Schemitsch,** ON; **Mohit Bhandari,** ON; **Brad Petrisor,** ON;

**Purpose:** To determine the effect of reamed versus nonreamed intramedullary (IM) nailing of femoral diaphyseal fractures on the rates of non-union and acute respiratory distress syndrome (ARDS).

**Method:** We searched the online databases of OVID, MEDLINE, EMBASE, PubMed, and the Cochrane collaboration for randomized clinical trials (RCT) from 1998 to 2009. Additional studies were identified by hand searches of major orthopaedic journals, reference lists of eligible studies, SCISEARCH, and title reviews of presentations from major orthopaedic trauma meetings. Inclusion criteria were trials evaluating the effect of reamed versus nonreamed closed interlocked intramedullary nailing of femoral diaphyseal fractures on the rates of nonunion or acute respiratory distress syndrome (ARDS) in skeletally mature adults. Exclusion criteria included patients with pathologic fractures, skeletally immature patients, as well as observational and other non-randomized studies.

**Results:** Seventy-two citations were initially identified out of 1,147 studies. 6 studies matched all eligibility criteria as assessed by three independent reviewers. A total of 941 patients with 956 femoral diaphyseal fractures treated with intramedullary nailing met the eligibility criteria. The relative risk of non-union (four trials, n= 456 patients) was 0.29 [95% confidence interval (CI), 0.14 to 0.57; p<0.00001] (ie. a 70% relative risk reduction of nonunion) in favour of a reamed intramedullary nail. There was no significant difference in the rates of ARDS following reamed or nonreamed nailing, relative risk for ARDS (two trials, n=397) 1.10 [95% CI, 0.27 to 4.54, p=0.18].

**Conclusion:** The study suggests that reamed intramedullary nailing of femoral diaphyseal fractures significantly reduces the risk of non-union as compared to nonreaming. The risk of ARDS was not statistically significant between groups; however there was a slight trend towards ARDS with reamed IM fixation.

146 - The Efficacy of a Locally Injectable Prostaglandin EP-2 Receptor Agonist on Fracture Healing

**Mohit Bhandari,** ON; **David D Thompson,** US; **Irina V Kaplan,** US; **Vishwas M Paralkar,** US; **Gojko Buljat,** US; **David Sanders,** ON; **John Schwappach,** US; **Slobodan Vukicevic,** HR; **EP-2 Study Group,** ON;

**Purpose:** Identification of novel therapeutics to accelerate acute fracture healing remains critical. A prostaglandin EP-2 receptor agonist (CP-533,536) has demonstrated acceleration of fracture healing in preclinical models.

**Method:** In a phase II randomized, blinded, placebo-controlled trial the efficacy of a single local injection of three doses of CP-533,536 (0.5mg, 1.5mg and 15mg) was compared to both placebo and a standard of care arm in patients with closed tibial shaft fractures treated with reamed interlocked intramedullary nails. Patients were followed at two week intervals to six months with a final evaluation at one year. Fracture healing was independently adjudicated by a radiologist panel and an orthopedic surgeon panel.

**Results:** Ninety-nine patients were enrolled ranging in age from 17-76 years. Baseline characteristics were comparable across treatment groups. No statistically significant differences in median healing time between any of the CP-533,536 treatment groups and placebo were observed based on radiology panel assessment, however significant differences were demonstrated by an orthopedic panel. At weeks eight, 10, 12, 14 and 16 a higher percentage of subjects in the CP-533,536 1.5 and 0.5 mg groups were considered healed compared to the placebo and the 15 mg groups by the orthopedic panel assessment. Moreover, the CP-533,536- 0.5 mg group showed a statistically higher (p=0.05) mean radiographic healing score than placebo treated group at weeks eight, 14, 16, 18, and 24.

**Conclusion:** CP-533,536 demonstrated accelerated healing in patients with acute tibia fractures by an orthopedic panel. Confirmatory trials are required to assure validity of the observed treatment effects.

147 - Tourniquet-induced Ischemia During Orthopaedic Trauma Surgery Causes Muscle Protein Oxidation Related to Changes In Muscle Oxygenation and Patient Gender

**Babak Shadgan,** BC; **Luke W Harris,** BC; **Darlene Reid,** BC; **Scott K Powers*,** FL; **Peter J O'Brien,** BC;

**Purpose:** Several variables related to tourniquet (TQ) inflation contribute to ischemic muscle injury. Among these the duration of ischemia has been identified as a primary factor. The purposes of this study were to investigate the following during and after TQ-induced ischemia during orthopedic trauma surgery: (1) muscle oxygenation changes measured by near infrared spectroscopy (NIRS); (2) muscle protein oxidation; and (3) correlations between muscle oxygenation / hemodynamics and oxidative changes.
Method: Consented patients aged 19-69 yrs (n=18) with unilateral ankle fracture requiring surgery at our institution were recruited. A pair of NIRS probes was fixed over the midpoint of the tibialis anterior muscle (TA) on both the injured and healthy legs. A thigh TQ was applied to the injured leg and inflated to 300 mmHg. Using the NIRS apparatus coupled to a laptop with data acquisition software, changes in oxygenated (O2Hb), deoxygenated (HHb), and total hemoglobin (tHb) levels in the TA of both legs were measured before and during TQ inflation, and after release until values returned to baseline. PRE surgical biopsies were collected from the peroneus tertius muscle (PT) immediately after TQ inflation and incision. POST biopsies were collected from the same PT immediately before TQ deflation. Oxidation of PT myosin, actin, and total protein was quantified using Western blot analysis of 4-hydroxynonenal (4-HNE) modified proteins. Data are reported as mean±SD.

Results: In PRE biopsies compared to POST biopsies there were large and statistically significant increases in the PT content of 4-NE modified myosin (174.4±128%; P<1×10^-6), actin (223.7±182%; P<5×10^-9), and total protein (567.5±378%; P<5×10^-7). There was a greater increase in PT protein oxidation in male subjects than in female subjects (50.8% difference; P<0.05). In the TA of the fractured side, there were moderate to strong linear correlations between total protein oxidation and: the relative change in tHb (r=-0.704) and O2Hb (r=-0.415) during the period of TQ inflation and the rate at which the muscle became reoxygenated following TQ release (r=0.502). There was no relationship between muscle protein oxidation and TQ time, nor between muscle protein oxidation and age of patients.

Conclusion: TQ-induced muscle ischemia for 21 to 74 min during lower extremity surgery leads to oxidative muscle injury as measured according to myofibrillar contractile protein oxidation. Importantly, we observed that when the TQ was “leaky,” local increases in muscle tHb were associated with a lower magnitude of protein oxidation, however, when local decreases in muscle O2Hb were observed, perhaps due to local blood loss below the TQ, more oxidative changes resulted. Intriguingly, gender appeared to influence the extent of muscle oxidative injury, but age did not. Surprisingly, there was no significant correlation between muscle oxidative injury and the TQ-induced ischemia interval. FUNDING: MSFHR, COF, BCLA.

148 - Long-term Follow-up of Whiplash Injury
Sameh El Sallakh, UK; Mohamed Mohamed, UK; Roony Mifsud, UK;

Purpose: Whiplash injury occurs due to motor vehicle accidents has its long term consequence, nevertheless very little is written about its long-term follow up. The aim of the study is to find out the long-term follow up of Whiplash injury and the factors affecting the long-term follow up

Method: It is a retrospective study which was done in Russell's Hall Hospital in the west midland in UK. 64 patients were selected in this study. Only 54 patients were replied. An inclusion criterion was Whiplash injury due to RTA in years 1995, 1996 and 1997. Initial examination was performed 5.6 +/- 4.5 days after trauma, and follow-up examinations 3, 6, 12, and 24 months. Exclusion criteria were any cervical spine bony injury, associate head injury and poly-trauma patients. The outcome measures used for assessment are SF36, Whiplash Disability Questionnaire score WDQS, and questions to cover their present symptoms, work circumstances before and after the injury, current and previous treatment

Results: In our study we found that the time it takes for the patient's symptoms to resolve varies, it took less than 6 weeks in 4 patients, between 6 weeks to 3 months in 10 patients, between 6 months to 1 year in 15 patients and more than one year in 3 patients. The average follow up time was 10.3 years. Our results did show these figures: 22 patients were still symptomatic 10 years after injury, 18 still complaining of pins & needles, 13 still having frontal headache and 7 having occipital headache. Headache was one of the symptoms which annoyed Whiplash injury patients. Headaches following Whiplash injuries were occipital, frontal or generalised. Headache was usually of Muscular contraction type, often associated with greater occipital neuralgia. 16 patients still had treatment in the form of pain killers or physiotherapy. The mean WDQS was less than 20 in 38 patients. The mean WDQS in patients with low back pain was 29.23 and for those without back pain were 12.53. In the smokers the mean whiplash score was 32.2. In the non-smokers the Whiplash score was 17.93. The mean WDQS in those who do not drink alcohol was 26.73 and in those who drink alcohol were 16.58.

Conclusion: Whiplash injury patients have long term residual symptoms mainly pins & needles as well as headache and dizziness. Claiming compensation is a bad prognostic factor on the long-term outcome of Whiplash injury patients. Drinking alcohol, Gender, BMI, treatment given after the initial injury and smoking have no effect on the long-term outcome of these injuries. Age & Low back pains are bad prognostic factors. Whiplash Disability Questionnaire score, SF 36 (for body pain) and time for symptoms to be relieved are sensitive outcome measures to assess those injuries.

Paper Session #16 Foot and Ankle

149 – Management of the Neglected Club Foot in the Older Child with the Taylor Spatial Frame
R Mervyn Letts, ON; Atef Hassan, AE;

Purpose: To assess the efficacy of the Taylor Spatial Frame in the correction of rigid long standing foot deformities in older children.

Method: Children presenting with rigid longstanding foot deformities were fitted with a Taylor Spatial Frame (TSF) utilizing specialized small foot rings. Prior to surgery an operative plan was devised including soft tissue release and osteotomies usually consisting of a curved midfoot osteotomy and a dome shaped hind foot osteotomy. About 30% correction was obtained at surgery and held with the
The Taylor Spatial Frame is an efficient and safe method to effect excellent correction of a rigid club foot deformity in combination with osteotomies and soft tissue releases of the foot.

***150 - Ankle Arthrodesis versus Total Ankle Arthroplasty: Prospective Outcome Cohort Study***

**Mark Glazebrook, NS; Patricia Francis, NS;**

**Purpose:** To compare the clinical outcomes of patients surgically treated for end stage ankle arthritis using total ankle arthroplasty or ankle arthrodesis.

**Method:** This is a single center clinical outcome study of the surgical treatment of patients with end stage ankle arthritis (n=81) using an ankle arthrodesis or total ankle arthroplasty. Clinical outcome was assessed using health related quality of life (SF36v2) and joint specific (Ankle Osteoarthritis Scale, American Orthopedic Foot and Ankle Hindfoot Scale and the AAOS Foot and Ankle Baseline Questionnaire(version 2000)) outcome scores. Complications were recorded as well.

**Results:** Preoperatively, all patients had significant physical and psychological morbidity. There was a significant improvement in the health related quality of life and the joint specific clinical outcome scores at 1, 2 and 3 years follow up (p-value <0.05). Complications included 5 (10%) non union, in the ankle arthrodesis cohort and 2 (6.7%) revisions for aseptic loosening in the total ankle arthroplasty cohort.

**Conclusion:** The results of this study indicate that surgical treatment of end stage ankle arthritis with ankle arthrodesis or total ankle arthroplasty equally improve clinical outcome in the short term with acceptable and similar complication rates.

***151 - Prospective Clinical and Radiographic Intermediate Outcomes of 113 Scandinavian Total Ankle Arthroplasties***

**Timothy R Daniels, ON; Murray John Penner, BC; D. Joshua Mayich, ON; Michael Bridge, BC;**

**Purpose:** The global utilization of total ankle arthroplasty (TAR) has been increasing over the past decade; however there are a limited number of published prospective studies assessing intermediate and long term outcomes. The purpose of this clinical series is to prospectively review the mid-term clinical and radiographic outcomes of the Scandinavian Total Ankle Replacement (STAR) performed at two Academic Canadian University Centres.

**Method:** Between 1998 and 2005, 113 STARs were implanted into 99 patients at two Canadian centres. Prospective clinical and radiographic follow-up was performed. Validated and non-validated outcome questionnaires consisting of the AAOS foot and ankle questionnaire (a composite questionnaire made up of unaltered versions of the SF-36), AOFAS Hindfoot score, Foot Function Index (FFI), Ankle Osteoarthritis Scale (AOS) were completed in one arm (63/113 implanted TARs). In the other arm, (50/114) the patients were followed retrospectively with the same measures. Both groups had prospective radiographic follow-up using measures described by Wood et al.

**Results:** The average follow-up for both groups was 46.3 ± 17.6 months (or 3.8 years). Of the 113 implanted STARs, 33 (29.2%) required a re-operation. Of those, 20 (17.7%) went on to be revised. Six patients had repeat revision operations for a total of 26 revision operations. Of the 26 revision operations 14 (54%) were polyethylene liner exchanges, and 12 (46%) were revision of the metallic components. The median time to revision was 39.5 months. Three prosthesis (2.6%) went on to have a deep infection of their STAR. One patient had infection in their revision IM Nail. Of the 113 initially implanted prostheses, 101 (89.3%) of the original TARs remained implanted at the conclusion of the study. Sustained benefit, across questionnaires, from the STAR was observed to persist to final follow up. 115/116 (99%) ankles showed evidence of osteolysis at the last STAR follow-up. The osteolysis was found to occur more commonly around the talar component, but occurred, for the most part, in a recognizable pattern around both the talus and the tibia. No significant differences between the two centers in pre-operative or intra-operative data were identified.

**Conclusion:** The STAR, in the mid-term, shows acceptable survival and revision rates. There are, however, some concerning findings on radiographic follow-up. It appears, upon initial investigation, that initial component position may be a factor that predicts concerning radiographic changes. Further investigation is required to substantiate this.

***Non-physician Triage in Patients with Low Back Pain, Sciatica and Spinal Stenosis***

**Brett Dunlop, ON; Laurie Molaughlin, ON; Charlie Goldsmith, ON;**
Purpose: Uncertainty around back pain management results in large volumes of patients with back related complaints being referred to orthopaedic surgeons for direction. The vast majority of these referrals are non surgical leading to unacceptable wait times (T1) across Canada. This reservoir delays not only those who are disabled with problems requiring a surgical remedy but also those who only require direction to appropriate conservative care. Physiotherapists with advanced training in orthopaedics possess skills in musculoskeletal interview, exam and Orthopaedic residents on the other hand must acquire spine specific skills in interview and exam, interpretation of radiographic exams, surgical decision making as well as surgical technique in a 2-3 month residency rotation. Our question was ‘Can an Experienced Physiotherapist Become Proficient in Triaging for Surgically Appropriate Patients After a 2-3 month ‘Residency ’.

Method: Following a 3 month clinical residency an experienced physiotherapist and a spine surgeon independently interviewed, physically examined and reviewed diagnostic imaging of 31 patients. It was then independently concluded whether the patients were candidates for surgical treatment, required conservative management or whether further investigations were necessary to make the final determination. The level of agreement was calculated using Chance Corrected Agreement or Kappa values. Operational definitions were reviewed and a second group of 29 patients were assessed.

Results: The initial Kappa score was .68 (considered good clinical agreement) and the final Kappa score was 0.84 (considered virtually interchangeable).

Conclusion: A 3 month period can prepare an experienced orthopaedic physiotherapist to triage a waiting list for surgical candidates. The therapist can add value through being better prepared to direct conservative options. Expediting triage will facilitate the right person getting to the right intervention within a reasonable time frame. Addressing the backlog of referrals will also help identify the magnitude of surgical need.

153- The Reliability of Differentiating Neurogenic Claudication from Vascular Claudication Based on Symptomatic Presentation
Melissa Nadeau, ON; M Patricia Rosas Rosas Arellano, ON; Kevin Gurr, ON; Stewart I Bailey, ON; Brian Taylor*, ON; Ruby Grewal, ON; Kirk Lawlor, ON; Christopher S Bailey, ON;

Purpose: Claudication is a common complaint of elderly patients. Lumbar spinal stenosis (LSS) and peripheral arterial disease (PAD) are the two main etiologies, producing neurogenic and vascular claudication respectively. Physicians initially diagnose claudication based on a “typical” symptom profile. The reliability of this symptom profile to accurately diagnose LSS or PAD as a cause of claudication is unknown, leading to the potentially unnecessary utilization of expensive and overly sensitive imaging modalities. Furthermore, clinicians rely on this symptom profile when directing treatment for patients with concurrent imaging positive for LSS and PAD. This study evaluates the reliability of various symptom attributes, which classically have characterized and differentiated the two.

Method: Patients presenting at a tertiary care center’s vascular or spine clinics with a primary complaint of claudication were enrolled in the study. Diagnosis of either LSS or PAD was confirmed with imaging for each patient. They answered 14 questions characterizing their symptoms. Sensitivity, specificity, positive and negative likelihood ratio (PLR and NLR) was determined for each symptom attribute.

Results: The most sensitive symptom attribute to rule out LSS is “triggering of pain with standing alone” (0.96). Four symptom attributes demonstrated a high PLR and three had low NLR for diagnosing neurogenic claudication (PLR= 3.08, 2.51, 2.14, 2.9; NLR=0.06, 0.29, 0.15). In vascular patients, calf symptoms and alleviation of pain with simply standing had a high PLR and NLR (PLR= 3.08 and 4.85; NLR= 0.31 and 0.36).

Conclusion: Only four of 14 “classic” symptom attributes are highly sensitive for ruling out LSS, and should be considered by primary care physicians before pursing expensive diagnostic imaging. Six symptom attributes should be relied upon to differentiate LSS and NLR. Numbness, pain triggered with standing alone, located in the buttock and thigh, and relieved following sitting, are symptom attributes which reliably characterize neurogenic claudication.

154 - The Multidisciplinary Inter-examiner Reliability of Patient Screening Assessments in a Hospital-based Spine Program: A Pilot Study
Paul B Bishop, BC; David Brunarski, ON; Charles Fisher, BC;

Purpose: Screening patients for appropriate treatment is a key component of an effective hospital-based spine service. To date, a standardized and validated method for carrying out this process has not been established. In particular, studies to determine who should staff these screening services, their safety and reliability have not been reported. The goal of this study was to determine the inter-examiner reliability of patient screening assessments by Chiropractors and Spine Physicians.

Method: Prospective observational cohort. 50 consecutive patients with acute lower back pain <16 weeks duration (QTFSD I, II) referred to a quaternary care hospital spine program were studied. The inter-examiner agreement for 10 physical examination procedures and 5 red flag conditions was calculated using the Cohen’s kappa value. Patients were assessed by one of three spine physicians and one of three Chiropractors for normal or abnormal deep tendon reflexes, nerve root tension signs; lower extremity sensory / motor deficit; muscle atrophy; Schober’s test and depth of lordosis. Any history suggestive of cauda equina, fracture, infection, spinal malignancy or progressive neurological deficit was recorded. The results were compared where applicable, with previously published kappa values for lower back examination procedures.
Results: Four of the 50 patients had one or more red flag conditions with an inter-observer reliability of 0.96; 8 of 10 physical examination procedures had a kappa value of > 0.9; the kappa for + sensory deficit was 0.66 and for + femoral nerve stretch test was 0.47.

Conclusion: In this pilot study, initial patient screening assessments carried out by Chiropractors and Spine Physicians had high inter-observer reliability in 8 of the 10 examination procedures tested and were superior to previously reported multidisciplinary inter-observer kappa values.

155 - Evaluation of Mortality Following an Odontoid Fracture in the Octogenarian Population
Alexandre Denault, AB; Ish Bains, AB; Ken Moghadam, AB; Richard W Hu, AB; Ganesh Swamy, AB;

Purpose: Odontoid fractures are the most common cervical spine injuries in the elderly. Although octogenarians are the fastest growing age group, limited data exists on the natural history after they sustain odontoid fractures. Published mortality rates vary greatly, but are high enough to elicit comparisons to post-hip fracture mortality. It has also been suggested that halo-vest immobilization independently predicts mortality.

Method: All traumatic odontoid fractures (type II or III) seen at our institution between 1996 and 2008 were identified and only patients who were ≥ 80 years of age were selected. A retrospective chart review was performed for injury characteristics, comorbidities, hospitalization details, treatment regimen and documented complications. Patients were stratified using the Charlson comorbidities index. The primary outcome was mortality at one year and was identified using a provincial database.

Results: 72 cases were identified. Median age was 86 years (range 80 to 102). Patient treatment regimens included rigid neck collar, Halo vest orthosis, surgery or a combination thereof. 31% percent of the cohort (22 patients) was treated by Halo vest immobilization. Overall 1-year mortality rate was 15% (n=11) with only 1 Halo-vest patient dying during this period. The majority of deaths (9 / 11) occurred in first 2 weeks following the injury.

Conclusion: Mortality rate in the octogenarian population sustaining an odontoid fracture is high and approaches the 1-year hip fracture mortality rate. The utilization of a Halo vest was not associated with increased mortality rate in our study. Optimal treatment regimens, and strategies to minimize morbidity, particularly in the early post-injury phase, necessitate further study.

156 - Brace Treatment for Adolescent Idiopathic Scoliosis – An Online Survey of the Canadian Spinal Deformity Study Group Surgeons
Douglas L Hill, AB; Eric C Parent, AB; Edmond Lou, AB; Marc J Moreau, AB; James K Mahood, AB; Douglas M Hedden, AB;

Purpose: Rigid full-time braces are the most common non-surgical treatment for adolescents with moderate severity of scoliosis and demonstrated growth remaining. The Scoliosis Research Society (SRS) has established guidelines on which patients with adolescent idiopathic scoliosis (AIS) should be offered brace treatment. This study surveyed Canadian surgeons on the demographics of patients with scoliosis attending specialty clinics and for their protocols for prescribing braces.

Method: An on-line survey of 41 questions was developed to document patient profiles and surgeon protocols for prescribing braces. Surgeons also selected whether they would recommend a brace in females with AIS based on a combination of three levels of maturity, with six levels of curve severity, and whether or not the curve was progressive. The survey was administered between July and November 2008 to the 30 paediatric spine surgeon members of the Canadian Paediatric Spinal Deformities Study Group. After one reminder, the response rate was 70% (21/30), representing 12 Canadian spine centres.

Results: The average age of referral to the scoliosis clinic was 11-12 years (10 of 20 respondents) and 13-14 years (nine of 20 respondents). Most (81%) of the centers required radiographs prior to the first clinic visit. All surgeons recommended bracing, but there was broad variation on who they considered should be braced, with three to twenty six of the 36 potential scenarios defined by maturity, progression, and curve severity variables selected. This high variability was also observed among surgeons in the same spine centre. All considered parental or family issues and patient acceptance when recommending a brace. Age and curve severity were criteria for bracing; skeletal maturity was the primary criteria for discontinuing bracing. The majority (81%) of braces prescribed were rigid full-time braces followed by rigid night-time braces (14%). Weaning was common (76%), but protocols varied. Detection of curve progression increased the likelihood of bracing for curves 80% agreement on bracing. Braces were not recommended by >50% of respondents for females with less than 1 year growth remaining regardless of progression or curve size.

Conclusion: In spite of SRS guidelines and general agreement that braces are effective, there is little agreement among surgeons on which females with AIS should receive brace treatment. The likelihood that a female with AIS will be prescribed brace treatment primarily depends on surgeon brace prescription patterns, rather than actual curvature of the spine.

157 - Metabolic Syndrome Increases the Risk of Prevalent Spine Osteoarthritis
Rajiv Gandhi, ON; Kenneth Woo, ON; Yoga R Rampersaud, ON;

Purpose: MetS has been shown to be a risk factor for chronic diseases such as cardiovascular diseases (CVD), including myocardial infarction and stroke, and dementia. Moreover, the risk factors that make up the MetS (central obesity, diabetes, high blood pressure, and dyslipidemia) have also been demonstrated to have independent relationships to degenerative joint disease. The relationship between the metabolic factors and spine OA have been examined by few, however the predictive value of MetS on the incidence or
prevalence of this disease has not been studied. In this study, we asked whether the prevalence of spinal OA increases with the number of MS risk factors.

**Method:** We reviewed data from a single surgeon, high volume, spine surgery practice between the years of 2002-2007. Demographic data including the components of the MetS risk factors were collected. Prevalent severe OA was defined as degenerative spondylolisthesis or cervical or lumbar stenosis causing neurologically based symptoms, and early OA as those with lumbar and cervical spondylolisthesis causing axial pain only. Logistic regression modeling was used to determine the odds (adjusted for age and sex) of having severe spine OA with an increasing number of the MetS risk factors.

**Results:** In our cohort of 1502 patients, there were 839/1502 (55.9%) patients defined as severe spinal OA and 663/839 (44.1%) patients with early OA. Those with severe OA were significantly older, with a greater percentage of females, and had a greater BMI than those with early spinal OA (p < .05). The prevalence of severe spinal OA varied across groups defined by the number of MetS risk factors: 353/748 (47.2%) in those with 0 MetS risk factors, 236/392 (60.2%) in those with 1 MetS risk factors, 148/228 (64.9%) in those with 2 MetS risk factors, 76/104 (73.1%) in those with 3 MetS risk factors, and 26/30 (86.7%) in those with all 4 MetS risk factors. The overall prevalence of MetS was 30/1502 (2.0%), 26/839 (3.1%) in the severe OA group and 4/663 (0.6%) in the early OA group. (p=.001) Logistic regression modeling showed the odds of having severe spinal OA increased with an increasing number of MetS risk factors relative to having no MetS risk factors. Those patients having defined as MetS had almost 4 times greater odds of having severe spinal OA as compared to those with no MetS risk factors, adjusted for age and gender [OR 3.9,(1.4, 11.6), p= .01].

**Conclusion:** The components of MetS are more prevalent in those with severe spinal OA causing neurological symptoms compared to those with spondylolisthesis causing axial pain. Future work should examine for an association between MetS and incident OA.

158 - Surgical Site Infection of the Spine: Construction of a Predictive Model to Define Need for Single versus Multiple Irrigation and Debridement

**John Street, BC; Christian DiPaola, US; Davor Saravanja, AU; Luca Boriani, IT; Michael Boyd, BC; Brian Kwon, BC; Scott Paquette, BC; Marcel Dvorak, BC; Charles Fisher, BC;**

**Purpose:** There is very little evidence to guide treatment of patients with spinal surgical site infection (SSI) who require irrigation and debridement (I&D) with respect to need for single or multiple I&D’s. The purpose of this study is to build a predictive model which stratifies patients with spinal SSI to determine which patients will go on to need single versus multiple I&D.

**Method:** A consecutive series of 128 patients from a tertiary spine center (collected from 1999-2005) who required I&D for spinal SSI, were studied based on data from a prospectively collected outcomes database. Over 30 variables were identified by extensive literature review as possible risk factors for SSI, and tested as possible predictors of risk for multiple I&D. Logistic regression was conducted to assess each variable’s predictability by a “bootstrap” statistical method. Logistic regression was applied using outcome of I&D- single or multiple as the “response”.

**Results:** 24/128 patients required multiple I&D. Primary spine diagnosis was approximately represented by ¼ trauma, ¼ deformity, ¼ degenerative and ¼ oncology/inflammatory/other. Six predictors: spine location, medical comorbidities, microbiology of the SSI, presence of distant site infection (ie. UTI or bacteremia), presence of instrumentation and bone graft type, proved to be the most reliable predictors of need for multiple I&D. Internal validation of the predictive model yielded area under the curve (AUC) of .84

**Conclusion:** Infection factors played an important role in need for multiple I&D. Patients with +MRSA culture or those with distant site infection such as bacteremia with or without UTI or pneumonia, were strong predictors of need for multiple I&D. Presence of instrumentation, location of surgery in the posterior lumbar spine and use of non-autograft bone predicted multiple I&D. Diabetes also proved to be the most significant medical comorbidity for multiple I&D.

159 - Do Non-steroidal Anti-inflammatory Drugs Inhibit Bone Healing? A Meta-Analysis of Cohort and Case Control Studies

**Emily R Dodwell, BC; Julius Gene Latorre, US; Emilio Parisini, US; Elisabeth Zwettler, AT; Divay Chandra, US; Kishore Mulpuri, BC; Brian Snyder, US;**

**Purpose:** Non-steroidal anti-inflammatory drugs (NSAIDs) are powerful analgesics, frequently used for post-operative pain control. However, concerns regarding the potential deleterious effects of NSAIDs on bone healing have compelled many physicians to avoid NSAIDs in patients with fractures, osteotomies, and fusions. The purpose of this study was to systematically review and meta-analyze the best clinical evidence regarding the effects of NSAIDs on bone healing.

**Method:** We performed a literature search for studies of fracture, osteotomy or fusion patients with NSAID exposure, and non-union as an outcome. Data on study design, patient characteristics and risk estimates were extracted. Pooled effect estimates were calculated. Study inclusion results were checked for evidence of publication bias. Metaregressions were performed to assess the impact of age, smoking, and study quality on reported risk of non-union.

**Results:** Seven spine fusion and four long-bone fracture studies were included. A significant association between lower quality studies and higher reported odds ratios for non-union was identified. When only higher quality studies were considered, seven spine fusion studies were analyzed, and no statistically significant association between NSAID exposure and non-union was identified (OR=2.2, 95%CI:0.8, 6.3). No statistically significant association was found in sub-analysis of patients exposed to high dose IV/IM ketorolac (OR=2.0, 95%CI:0.4, 11.1), low dose IV/IM ketorolac (OR=1.2 95%CI:0.3, 4.5), or standard oral NSAIDs (OR=7.1, 95%CI:0.1, 520). In sub-analysis of the four most clinically relevant studies of adult spine fusion patients with well defined peri-operative NSAID exposure, no statistically significant association was found between NSAID exposure and risk of non-union (OR=0.8 95%CI:0.4, 1.4).
Conclusion: Studies on NSAID exposure in long-bone healing settings were of lesser quality than studies in the spine fusion setting. Within the spine literature we could not demonstrate any increased risk of non-union with NSAID exposure. Randomized controlled trials (and meta-analyses of such trials) on the impact of standard NSAID and COX-2 inhibitor exposure in spine and long-bone fracture, fusion and osteotomy populations are warranted to confirm or refute the findings of this meta-analysis of observational studies.

160 - Clinical Practice Guideline-based Treatment is Not Effective for All Patients with Acute Lower Back Pain
Paul B Bishop, BC; Charles Fisher, BC; Jeff Quon, BC; Marcel Dvorak, BC;

Purpose: Clinical practice guideline (CPG) concordant treatment (Ctx) has been shown to be more effective than CPG discordant care (Dtx) in a heterogeneous cohort of patients with acute lower back pain (ALBP). However, patients with underlying spine pathology (e.g. stenosis, disc degeneration, facet joint arthropathy) or without identifiable spine pathology may all present solely with ALBP. At present, it is unknown if underlying spine pathology influences the outcome of Ctx. The purpose of this study was to determine if Ctx is more effective than Dtx in patients with differing underlying spine pathology who present with ALBP.

Method: A Two-arm, randomized control trial with stratified analysis. Inclusion: Ages 19-59; QTFS I, II ALBP <4 weeks. Exclusion: “Red Flag” conditions, co-morbidities contraindicating Ctx. The primary outcome was the difference between Ctx and Dtx Roland Morris Disability (RDQ) scores at 16 weeks post baseline between study groups. Secondary outcomes: differences in Bodily Pain (BP), Physical Functioning (PF) SF-36 domain scores at 16 weeks. Patients were assessed by a spine physician and randomized to Ctx or Dtx. Patients were stratified on the basis of CT or MRI evidence of: 1) spinal stenosis; 2) disc degeneration; 3) facet joint arthropathy; or 4) no identifiable pathology. Hospital / University Ethics approval was obtained.

Results: Eighty-eight patients were recruited; 39 in Ctx & 38 in Dtx group completed the study. Baseline prognostic variables were evenly distributed between groups. Outcomes: mean difference in 16 week RDQ, BP and PF scores between Ctx and Dtx was statistically greatest in group 4 (p<0.001). There was no significant clinical improvement in RDQ, BP or PF scores in either the Ctx or Dtx in group 2.

Conclusion: Ctx was more effective than Dtx in patients with no identifiable spine pathology and ineffective and equivalent to Dtx in patients with underlying disc degeneration.

Paper Session #18 COA Knee Reconstruction

161 - Total Knee Arthroplasty After Distal Femoral Varus Osteotomy: Mid-term Results of Selectively Stemmed Posterior Stabilised Components
Michael G Zywiel, US; Yona Kosashvili, ON; Allan E Gross, ON; Oleg Safir, ON; Dror Lakstein, ON; David Backstein, ON;

Purpose: The literature regarding the outcome of total knee arthroplasty following distal femoral varus osteotomy is limited. The largest published series to date of eleven such patients suggested that medio-lateral constrained implants are commonly required as ligament balancing is difficult. This study presents mid-term outcomes of patients treated with total knee arthroplasty following distal femoral varus osteotomy at a single center.

Method: Twenty-two consecutive distal femoral varus osteotomies (21 patients) converted to total knee arthroplasties were reviewed at a mean follow-up of five years (range, two to 14 years). The mean duration between osteotomy and conversion to arthroplasty was 12 years (range, three to 21 years). In 14 patients (15 knees) the underlying etiology for the femoral osteotomy was primary knee osteoarthritis with valgus deformity, while in seven patients the procedure was performed to unload a fresh osteochondral allograft of either the lateral tibia (five patients) or femur (two patients). It is the authors’ routine to use posterior stabilized implants were used in all total knee arthroplasty surgeries. Femoral stems were used in six knees in which the bone quality was clinically determined by the surgeon to be sufficiently deficient to predispose to periprosthetic fractures, while the remaining sixteen knees were treated with unstemmed components. Modified knee society scores were used to evaluate the clinical outcomes preoperatively and at most recent follow-up.

Results: The mean knee society knee and function scores in surviving knees improved from 50 points (range, 10 to 75 points) and 50 points (range, 30 to 70 points) pre-operatively, to 91 points (range, 67 to 100 points) and 64 points (range, 50 to 70 points) at final follow-up, respectively. The mean arc of motion improved from 94 degrees (range, 70 to 115 degrees) to 114 degrees (range, 90 to 130 degrees). Two patients underwent revision arthroplasty for polyethylene wear and component loosening at eight and 11 years following the index arthroplasty, respectively. There were no fractures, infections or wound complications.

Conclusion: Total knee arthroplasty following distal femoral varus osteotomy reliably decreases pain and improves knee function. Standard posterior stabilized components provide satisfactory stability after appropriate ligamentous balancing, without the need for stemmed or highly constrained components in the majority of patients.

162 - Revision Total Knee Arthroplasty for Malrotational Implant Positioning
Sanket Diwanji, QC; Jean-Michel Lafortosse, QC; Martin Lavigne, QC; Pascal-André Vendittoli, QC;

Purpose: Even with modern ancillary and good surgical experience, rotational implant positioning is sometimes sub-optimal, leading to poor results. Except for obvious cases with patellar instability, the symptoms are often vague and non-contributive to the diagnosis of
failure. This is why implant malpositioning and particularly malrotational positioning remain an underestimated cause of failure after primary total knee arthroplasty (TKA). We report our experience with TKA revision for rotational malpositioning.

**Method:** We retrospectively assessed the results of TKA revisions in 22 knees for malrotational positioning. In all cases, malrotational implant positioning was confirmed by CT-scan according to Berger’s protocol.

**Results:** Mean age was 66 years (47-74) at the time of the primary TKA. After the index procedure, all patients presented early anterior knee pain with patellar instability (tilt and subluxation in ten cases, and permanent patellar dislocation in two cases). Malrotational positioning predominated on the tibial component with mean 23° internal rotation. Mean cumulative malrotation (tibial plus femur) was 22° internal rotation. All but four patients underwent femoral and tibial component revision. In two cases, only the tibial component was revised, and in two other cases, isolated transposition of the anterior tibial tuberosity was carried out. One was a failure, and finally underwent a successful full revision. At a mean follow-up of 30 months (12-60), we noted significant functional outcome improvement. One patient, who underwent a patellectomy previously at the index TKA procedure, had persistant anterior knee pain. No patient presented patellar instability.

**Conclusion:** The diagnosis of implant malrotational positioning is sometimes difficult. The most common errors are tibial component positioning. In case of suspicion of malrotational positioning, protocolized CT-scan allows quick and simple diagnosis. If the malrotation is confirmed, TKA revision should be performed upon patient disability and severity of the symptoms. It is important not to delay the surgery, particularly in cases of patello-femoral dislocation because of the risks of developing soft tissue contractures resulting in a more difficult revision procedure.

**163 - Minimum Ten Year Results of the Genesis II Total Knee Arthroplasty System**  
Richard W McCalden, ON; Robert B Bourne, ON; Kory D Charron, ON; Steven JM MacDonald, ON; Cecil H Rorabeck, ON;

**Purpose:** The Genesis II total knee arthroplasty system was introduced in 1996 as the next evolution in TKR design characterized by “built-in” femoral external rotation and improved trochlear design to optimize patellar tracking and femoral/tibial kinematics, as well as a polished tibial base plate and ethylene-oxide sterilized polyethylene to minimize wear. The purpose of this prospective study was to evaluate the long-term (minimum 10 year) clinical and radiographic results and survivorship of this novel TKA implant system.

**Method:** Between 1996 and 1999, 478 Genesis II Primary TKRs were implanted and followed prospectively in 414 patients (mean follow-up 11.25±1.11 years). Diagnosis at index surgery included: 94% osteoarthritis, 5% inflammatory arthritis, 1% other diagnoses. Average age at index TKR was 68 years (range 38 to 93 years). There were 149 posterior cruciate retaining (31%) and 329 cruciate sacrificing (69%) knees implanted. Patella resurfacing was performed on 89% (432) of the cases. Sixty-seven deaths occurred prior to 10 years follow-up. Patients were followed prospectively using validated clinical outcome scores (WOMAC, SF-12, Knee Society scores) and radiographs. Kaplan-Meier survival analysis was performed.

**Results:** All health-related outcomes were significantly improved from preoperative with a mean Knee Society Score and WOMAC at last follow-up of 162 and 69, respectively. To date, 16 revision procedures have been performed. Revisions for infection included six two-stage revisions and two cases of irrigation & debridement with polyethylene exchange. In addition, there were three re-operations for stiffness and one for patellar instability. To date, there have been only two revisions for aseptic loosening and/or osteolysis. Excluding revisions for infection, the Kaplan-Meier survivorship analysis of the total knee system was 98.9±0.5% at five years and 98.2±0.6% at 10 years.

**Conclusion:** The Genesis II total knee arthroplasty system, characterized by “built-in” femoral external rotation, improved trochlear design, a polished tibial base plate and ethylene-oxide sterilized polyethylene, has demonstrated excellent clinical & radiographic results and long-term survivorship (98% at 10 years) at our institution.

**164 - Outcomes of Total Knee Arthroplasty in Patients Under Fifty-five**  
Maxwell McCabe, ON; Steven JM MacDonald, ON; Richard W McCalden, ON; Robert B Bourne, ON; Douglas D Naudie, ON;

**Purpose:** Total knee arthroplasty (TKA) is a proven intervention in the management of end-stage knee arthritis. However, the demands of younger, more active patients may result in increased rates of wear and aseptic loosening. The purpose of this study was to assess the long-term outcome of a large cohort of young patients, and to assess if the outcomes of cemented implants differed from non-cemented implants.

**Method:** Between 1984 and 2003, 350 TKAs were performed in 283 patients who were under 55 years old. Patients were followed a minimum of 5 years. Mean age at time of surgery was 49.0±5.5 years; 64% of patients were female. Primary knee pathologies included degenerative and post-traumatic arthritis (271), inflammatory arthritis (62), and others (17). Multiple implant designs were used; 296 knees were cemented and 54 were non-cemented. The Knee Society Clinical Rating Score (KSCRS) at latest follow-up was calculated. The Kaplan-Meier survivorship was calculated using an endpoint of revision total knee arthroplasty.

**Results:** Mean follow-up was 8.7±3.4 years. Seventeen knees were revised at a mean of 7.1±4.4 years after the index procedure. Fifteen patients (twenty-five knees) died. Fifty-one patients (sixty-two knees) were lost to follow-up. Sixty patients (sixty-seven knees) had incomplete KSCRS forms. Average function and knee domains of the KSCRS were 70.0±26.7 and 87.3±16.2 respectively. The Kaplan-Meier survival at five, ten, and fifteen years was 0.965±0.011, 0.941±0.015, and 0.933±0.017. The rate of revision was 5.9%. There was no statistically significantly difference observed between the outcomes of cemented and non-cemented implants, male and female patients, or inflammatory versus non-inflammatory arthritis.
Conclusion: This study demonstrates that total knee replacement in younger patients can demonstrate excellent survival rates free of revision. There does not appear to be an obvious survival advantage of cementless designs, or difference in outcomes based on sex of the patient or primary diagnosis of inflammatory or non-inflammatory arthritis.

165 - What Is the Fate of Recurrent Deep Sepsis Following Two-Stage Revision for Infection in Total Knee Arthroplasty
Siva K Ariaretnam, ON; Robert B Wallace, ON; Robert B Bourne, ON; Steven JM MacDonald, ON; Richard W McCalden, ON; Douglas D Naudie, ON; Kory D Charron, ON;

Purpose: Approximately, 10% of two-stage TKA revisions for deep sepsis become re-infected. The purpose of this study was to determine the success in terms of sepsis eradication and factors associated with failure of repeat two-stage revision TKA.
Method: Between 1991 and 2006, 129 two-stage revision TKRs for deep sepsis were performed. Ten cases which became re-infected were identified. These unfortunate patients, representing 8% of the all the two-stage TKA revisions performed during this time period, are the focus of this study. Their progress and treatment interventions were followed for the purposes of this study.
Results: Ten patients were identified with a two-stage revision TKA which became re-infected. Mean patient age was 72 with 40% being female. Following recurrent sepsis all patients went on to require more than one further two-stage revision (mean 3.67 further revision surgeries). Infection was only successfully eradicated in 28.7% of cases, the remaining require chronic suppressive therapy or have ongoing active infection. Two patients went on to have an arthrodesis (both remain on suppressive anti-biotics) and one patient had trans-femoral amputation. Staph Aureus and Coagulase neg Staph accounted for 80% of primary infective organisms with only one primary infection with methicillin resistant staph aureus (MRSA). Cultures at subsequent revisions were the same organism in 67% cases. Additional organism cultured included Pseudomonas and Propionibacterium. These patients had an increased incidence of multiple medical co-morbidities including Type-2 Diabetes Mellitus and Rheumatoid Arthritis.
Conclusion: Patients with recurrent sepsis after a two-stage revision for infection in TKR all required multiple further surgeries. Eradication of infection was only achieved in 28.7% cases. Risk factors for recurrent sepsis include Rheumatoid Arthritis and Type-2 Diabetes Mellitus.

166 - A 5 to 12-Year Review of the Prostalac Functional Spacer in 2-Stage Revision for Infected Knee Arthroplasty
Bas A Masri, BC; Christopher R Gooding, BC; Nelson V Greidanus, BC; Donald S Garbuz, BC;

Purpose: Between 1 and 2% of knee arthroplasties are complicated by infection with its associated patient morbidity. Two stage revision remains the gold standard with the minimum interval considered acceptable between the two stages as 6 weeks, but in some cases can be considerably longer depending on the patients’ clinical response to the first stage and intravenous antibiotics. The interval between the 2 stages is to allow eradication of the causative organism, however, this can result in considerable morbidity for the patient. Patients often have a poor range of movement, instability and considerable discomfort during this time and as a result have poor mobility. Further complications can be encountered at the time of the 2nd stage with considerable scarring of the soft tissues, in part secondary to the lack of mobilisation. Traditionally, spacers which are non-articulating have been used, however, problems of instability, scarring and bone erosion have been reported in the literature. The Prostalac knee spacer constitutes an antibiotic loaded acrylic cement body with a metal on polyethylene surface and enables the patient to undergo rehabilitation in the interval between the 2 stages and may also help maintain soft tissue planes as a result. Previous published results with a mean follow up of 48 months suggest the spacer is just as successful at eradicate infection (91%) as other techniques. The aim of this study is to review 119 patients with a minimum follow up of 5 years.
Method: The Prostalac Knee spacer has 2 components, a femoral and a tibial. Each are made of antibiotic-loaded acrylic cement with a small articulation of metal on polyethylene. The spacers are made from moulds so that a component of a suitable size and thickness could be made. This was a retrospective review of 119 consecutive patients. The inclusion criteria included all patients who had undergone a 2 stage revision with the Prostalac Knee spacer who had more than 5 years of follow up. Patients were assessed using the WOMAC, SF-12, Oxford Knee Score and the Knee Society Score.
Results: Thirteen patients (10.9%) out of a total of 119 had recurrence of infection. This gives an overall rate of control of infection of 89%. Of the 46 patients who completed the outcome score questionnaires with more than 5 years follow up, the mean WOMAC score was 65.9. Oxford Knee score was 61, SF-12 (physical component) was 35.7. SF-12 (mental component) was 54.8.
Conclusion: Although the Prostalac components include polyethylene and metal, they do not seem to have a detrimental impact on the rate of control of infection since our results were similar to those previously reported with other best practice techniques. It is our impression that the Prostalac functional spacer allows earlier pain free mobilisation, allowing the potential for earlier hospital discharge. The savings obtained from earlier hospital discharge greatly outweighing the increased cost of the Prostalac functional spacer system.

167 - Cemented Short Tibial Stems in Revision Knee Arthroplasty: Cohort Report of 77 Patients
Vaughan R Poutawera, ON; Jeffrey D Gollish, ON; Ahsan J Butt, ON;

Purpose: Total knee arthroplasty is one of the most successful modern surgical interventions with excellent clinical outcomes and implant survivorship. Nevertheless, with the increasing numbers of primary knee replacements being performed and increasing life expectancy, the need for revision arthroplasty continues to grow and is expected to grow considerably in to the future. Stemmed implants are commonly used in revision knee arthroplasty to provide adequate support for the joint interfaces. Controversy exists amongst surgeons as to the relative merits of cemented versus uncemented stems in revision knee arthroplasty. Cementing stemmed
168 - The Impact of Baseline Mental Health Status on Outcomes for Primary Knee Replacement Patients

Purpose: The purpose of this study was to examine the effects of baseline mental health on functional outcomes after primary knee arthroplasty by reviewing the data collected in a multi-center prospective observational cohort study. We hypothesized that those patients with lower baseline mental health status would demonstrate significantly worse outcomes vs. their counterparts with higher mental status following primary total knee arthroplasty.

Method: Data from a multi-center prospective cohort study of PS (posterior stabilizing implant) and CR (cruciate retaining implant) primary knee arthroplasty were compared to determine the relationship between baseline mental health status and functional outcomes post-surgery. Subjects were followed from the time of the index surgery to monitor outcomes and complications. Validated quality of life instruments, including SF-36, WOMAC, Knee Society Score, and an activity scale were used. The rates of improvement from 0 to 12 months were analyzed for this study.

Results: Baseline data was available for 436 subjects in the primary PS study and 493 subjects in the primary CR study. Patients improved significantly on all SF-36 and WOMAC components between baseline and 12 months post-surgery. Correlation and regression analysis between WOMAC and SF-36 showed that Global Health (GH), Mental Health (MH), and Mental Component Score (MCS) subscales on the SF-36 were significantly associated with positive post-operative changes in WOMAC scores.

Conclusion: This study examined the effects of baseline mental health on functional outcomes after primary knee arthroplasty and found that baseline mental health was a significant predictor of functional outcomes twelve months after surgery. This relationship between mental health and outcomes needs to be examined carefully to help surgeons better prepare their patients for surgery.

169 - Functional Outcome of Revision Total Knee Replacement – is it as Poor as We Think it is?
Thomas R Turgeon, MB; Eric R Bohm, MB; Martin J Petrak, MB; Michael Sinaisky, MB;

Purpose: While it is generally accepted that the results of revision total knee replacement (TKR) are inferior to those of primary TKR, there is little published information documenting this. The purpose of this study is to compare patient-reported functional outcomes following primary and revision total knee arthroplasty patients using standardized, validated outcome metrics.

Method: Using data from an academic arthroplasty database, we undertook a review of health related quality of life (SF-12) and disease specific measures (WOMAC) of patients undergoing either primary or revision TKR. The sample included 39 patients who had undergone revision TKR for reasons other than infection, and 39 patients who had undergone primary TKR matched by gender, age, modified Charnley classification, and number of years of follow-up. Student’s t-test was used to compare both groups. Average length of follow up was 2 years.

Results: The mean age was 65 years. Sixty percent (67%) of the patients were female. Despite being matched by age, gender and modified Charnley classification, there were significant differences in post-operative functional scores. The revision TKR group’s mean WOMAC score was 73 (SD 17), compared to the primary group’s mean score of 84 (SD 14), p=0.002. Similarly, the revision group’s mean SF-12 PCS score was 35 (SD 8) compared to the primary group’s superior score of 44 (SD 10), p<0.0001. There was no differences detected in post-operative SF-12 mental component scores; 49 (SD 12) for the revision group compared to 53 (SD 10) for the primary group, p=0.11.

Conclusion: This study confirms the general clinical impression that the functional results of revision TKR are inferior to primary TKR, as measured by both the WOMAC and SF-12 tools.

170 - Complications Following Minimally Invasive Total Knee Replacement as Compared to Traditional Incision Techniques: A Meta-analysis
Rajiv Gandhi, ON; Holly Smith, ON; Kelly Lefaivre, BC; J Roderick Davey, ON; Nizar N Mahomed, ON;
Purpose: Minimally invasive surgery (MIS) knee replacement surgery has experienced a recent surge in popularity, driven by the patient concerns of a faster recovery time and a shorter, more cosmetic scar. However, the evaluation of any new medical therapy must include a detailed evaluation of both efficacy and safety outcomes. The primary objective of our meta-analysis was to compare the incidence of complications between minimally invasive (MIS) and standard total knee replacement (TKR) approaches.

Method: We reviewed randomized controlled trials comparing minimally invasive TKR to standard TKR. After testing for publication bias and heterogeneity, the data were aggregated by random-effects modeling. Our primary outcome was the number of complications. Our secondary outcomes were alignment outliers, Knee Society Function Scores, and Knee Society Knee Scores.

Results: We had a total of 9 studies evaluating our primary outcome. Average follow up time ranged from 3 to 28 months. There was no significant publication bias in our study.

The combined odds ratios for complications for the MIS group and alignment outliers were 1.58 (95% CI: 1.01 to 2.47) p<0.05 and 0.79 (95% CI: 0.34 to 1.82) p=0.58 respectively. The standard difference in means for Knee Society scores was no different between groups.

Conclusion: The results of this meta-analysis demonstrate a statistically significant increase in complication rates with MIS TKR when compared to standard TKR. There were no significant differences in postoperative alignment or KSS at 3 months between the two groups. MIS knee surgery should be approached with caution.

Paper Session #19 COA Upper Extremity

171 - Indications for SLAP Type II Repairs: Impact of Age and Associated Pathology on Clinical Outcomes
Richard M Holby, ON.; Helen Razmjou, ON; Eran Maman, IL;

Purpose: The purposes of this study were to examine factors that influenced the decision to repair a SLAP Type II lesion and to examine the difference between patients with and without a SLAP repair.

Method: Prospectively collected data of patients who had a SLAP Type II lesion were reviewed. Patients who had a repair were compared with those who did not have a clinical indication for repair. Disability outcome measures collected pre and 2 years post-operatively were the American Shoulder and Elbow Surgeons (ASES) and the Constant-Murley scores (CMS). Paired and independent t-tests and logistic regression were performed.

Results: One hundred and six patients (83 males, 23 females), mean age=50 (SD=14, range 18-81), with a SLAP Type II lesion were identified. Eleven patients (10%) had isolated SLAP pathology for which they received a repair. The remaining 95 (90%) patients had concomitant pathologies related to rotator cuff, instability, osteoarthritides, and other pathologies. Repair of the SLAP lesion was felt to be clinically indicated in 43(45%) of patients with combined lesions. Factors that influenced the decision to repair the SLAP lesion were age, nature of the associated pathology, the presence of a large or massive full thickness rotator cuff tear, anterior instability, and a partial biceps tear greater than 50% that required a tenodesis. Significant improvement was observed in the ASES and CMS scores (p <0.0001) whether or not a SLAP repair was performed.

Conclusion: This study indicates that age and presence of certain associated pathologies influence the need for SLAP Type II repair. A statistically significant improvement in strength and disability level is observed in patients with SLAP Type II lesions associated with concomitant pathology, despite not having the SLAP lesion repaired. The indications for SLAP Type II repair in the presence of other pathologies are discussed.

172 - Revisited: Reliability of the Walch Classification of the Glenoid in Glenohumeral Osteoarthritis
Dominique M Rouleau, QC; Jake Kidder, US; Juan Pons de Villanueva, ES; Savvas Dynamidis, IT; Michael De Franco, US; Gilles Walch, FR;

Purpose: The glenoid status is a crucial aspect of planning for shoulder replacements. This study revisits the classification proposed by Walch et al and discusses its value to orthopedic surgeons in terms of reproducibility and reliability.

Method: Three evaluators viewed one hundred-sixteen (116) shoulder CT-scans with primary glenohumeral arthritis and classified glenoid wear according to Walch classification two times. The validation study was done for three sets of data: Set I: the complete classification: A1, A2, B1, B2, C. Set II: regrouping with main categories: A, B, C. Set III: regrouping categories according to glenoid facet morphology; Normal concavity: A1, A2, B1; Biconcave glenoid: B2; Retroverted glenoid: C.

Results: Intra-observer Kappa values for Observer 1, 2, and 3 averaged 0.866 (0.899, 0.927, 0.773) for Set I; for Set II, the values averaged 0.915 (0.955, 0.975, 0.814); and for Set III, the values averaged 0.874 (0.897, 0.948, 0.777), all excellent values. Inter-observer reliability values for Set I averaged 0.621 (0.776, 0.512, 0.574), indicating good agreement; for Set II, the values averaged 0.759 (0.880, 0.713, 0.685), indicating excellent inter-observer agreement; and for Set III, the average was 0.642 (0.825, 0.519, 0.581), indicating good inter-observer agreement.

Conclusion: A clarification of the Walch et al classification of the osteoarthritic glenoid was necessary, especially with regards to the wordings of categories B2 and C. When used properly, it is a reliable and valuable tool for orthopedic surgeons of all levels of experience in the evaluation of the osteoarthritic glenohumeral joint.
173 - Prospective Clinical Outcome of the Delta III Prosthesis for Shoulder Pseudoparalysis: The Initial Canadian Experience

Daniel P Goel, US; Darren S Drosdowech, ON; Joy Macdermid, ON; Kate losipchuk, ON; Paul Jarman, ON; Kenneth J Faber, ON;

**Purpose:** The reverse total shoulder arthroplasty (RTSA) has shown improvement in both pain control and function in recent studies. The purpose of this study was to prospectively analyze functional outcomes and strength in patients following the use of the Delta III prosthesis in a single center.

**Method:** Patients treated by one of two surgeons were prospectively evaluated following RTSA. An independent observer administered the Constant Score, SF-12, Shoulder Osteoarthritis (SOAQ), ASES, DASH questionnaires and patient satisfaction. Isometric strength testing was performed using the Powertrack II dynamometer. Follow-up for all patients was available up to 5 years following surgery.

**Results:** The Delta III RTSA was performed on 51 study patients (67% female, mean age 74 (SD=10)). Improvements following surgery were noted in Quality of life (SF-12 Physical Summary= 30 to 38); shoulder disability (SOAQ= 144 to 79; ASES 7 to 15; DASH= 61 to 46; Constant 21 to 56), Symptoms (SOAQ symptoms 40 to 22), Physical impairments as determined by strength (External rotation = 3 to 5 Nm, Abduction 4 to 10 Nm); and ROM (Flexion= 51 to 115°, abduction 45 to 106°); p<0.05. All patients had follow up between 2-5 years. Satisfaction was high (86% extremely, 3% not at all).

**Conclusion:** Our data demonstrates significant improvements in quality of life, symptoms, patient satisfaction and disability with reduced and high at more than 2 years following RTSA. Novel to this study is improved objective evidence of strength in functional planes of motion. This is the first Canadian study to demonstrate such improvements in patients following RTSA.

174 - Locked-plate Designs for Proximal Humerus Fractures Perform Better Than the Conventional Cloverleaf Plate in an Osteoporotic Model

Adrienne M Kelly, NS; Kelly Trask, NS; Ross K Leighton, NS;

**Purpose:** Proximal humeral fractures are a commonplace injury, especially in the elderly population. Management is not always straightforward, and is particularly challenging when bone quality is poor. In recent years, locking plates have become available for the internal fixation of many types of fractures, including those of the proximal humerus, and a growing trend in their use has been noted. This is a randomized biomechanical study to evaluate the mechanical stability in simulated osteoporotic bone of three fixation plates, two locking and one conventional, for unstable two-part proximal humeral fractures.

**Method:** Eighteen synthetic humeri were plated with six bones in each of three groups: Synthes Cloverleaf Plate, Synthes Locked Compression Plate Proximal Humerus, and Smith and Nephew Periarticular Locking Plate for Proximal Humerus. Screw holes were overdrilled to simulate osteoporotic purchase. The distal humeral condyles were potted in autobody cement in polyvinylchloride tubes. An eight millimeter osteotomy gap was made at the base of the greater tuberosity to simulate an unstable two-part fracture. Cyclic axial compression testing was done in the vertical plane in 20 degrees of abduction to simulate physiologic loading. Measurements of plastic deformation of the construct were quantified by comparing RSA images taken before and after loading. Following cyclic axial compression testing, quasi-static torsion testing was done in the horizontal plane until construct failure. Failure was defined as the point where the linearity of a load-displacement curve is lost or where visible failure of the fixation occurs.

**Results:** No plates were loaded to failure. The locked plates were significantly stiffer in axial compression and torsion than the Cloverleaf plate. There was no difference between locked plates. The maximum total point motion seen on the RSA analysis was more than 4 times greater in the Cloverleaf group relative to either locked construct and no difference between the Synthes and Smith and Nephew locked plates was again seen. The majority of the motion in the Cloverleaf construct appeared to be in rotation about the anteroposterior axis (lateral rotation).

**Conclusion:** This study supports that locked plates, regardless of manufacturer, are stiffer in axial compression and torsion than Cloverleaf plates and result in less displacement in an unstable fracture pattern in an osteoporotic bone model.

175 - Displacement of the Radial Head about the Capitellum: The Radio-Capitellum Ratio (RCR), a New Validated Method to Measure It

Emilie Sandman, QC; Dominique M Rouleau, QC; G. Yves Laflamme, QC; Fanny Canet, QC; Georges S Athwal, ON; Benoit Benoit*, QC; Yvan Petit, QC;

**Purpose:** The literature contains little information on an objective method of measuring radiocapitellar joint translations, as would be seen with joint instability. The purpose of this study was to develop and validate a measurement method that was simple and that could be easily reproducible in a clinical setting or intra-operatively to assess radiocapitellar joint translations.

**Method:** We performed a radiological study on a synthetic elbow specimen in order to quantify radial head translations as related to the capitellum: the Radio-capitellum ratio (RCR). Thirty (30) lateral elbow x-rays were taken in different magnitude of subluxation of the radial head. The subluxation was created randomly by manipulation. X-rays where taken by fluoroscopy to obtain a perfect lateral view of the distal humerus. First, the evaluators determined the long axis of the radius and the center of the capitellum. The displacement of the radial head (in mm) was obtained by measuring the distance of the line perpendicular to the long axis of the radius passing through the center of the capitellum. Then, in order to adjust for variation of magnification, a ratio of the displacement of the radial head about the diameter of the capitellum was done. The RCR ratio would be of zero because the long axis of the radius always crosses the center of the capitellum in a perfectly aligned joint. A five mm translation of the radial head and a capitellum diameter of twenty (20) mm would give a RCR of 25% and would be positive if anterior and negative if posterior. The measurements were done two times at one week intervals by three independent evaluators to test inter-observer agreement and intra-observer consistency. The radiological incidences
were randomly ordered to minimize observer recall bias. Intra/inter-observer reliability was calculated using Intra-Class Correlation (ICC) and paired T-tests.

**Results:** The mean translation in the trial group was of 6.06% (SD 70.7%) from -167% to 125%. A result over 100% means that it is a complete dislocation if the axis of the radius is outside of the capitellum. Negative values signify posterior translation and positive values an anterior translation. Intra-observer reliability was excellent for the Radio-capitellum ratio (ICC 0.988 and 0.995) and inter-observer reliability was excellent (ICC 0.984 in average). Paired T-test results confirm a high intra-observer repeatability (p=0.97 and p=0.99) as well as a large inter-observer reproducibility (p=0.98 in average).

**Conclusion:** The proposed measurement of radial head translation about the capitellum (in percent): radio-capitellum ratio (RCR) has excellent inter- and intra-observer reliability when using our measurement method.

176 - Measurement Properties of Disability Outcome Measures in Patients with Advanced Osteoarthritis of Shoulder

Helen Razmjou, ON; Richard Holtby, ON; Suzanne Denis, ON; Terry Axelrod, ON; Robin R Richards, ON;

**Purpose:** The purpose of this study was to examine the measurement properties of four commonly used disability measures. We hypothesized that all measures would have a high (0.8 or >0.8) internal consistency and ability to discriminate between men and women's level of disability. A moderate convergent validity (0.5 to 1.00).

**Method:** This was a prospective longitudinal study of patients with advanced primary osteoarthritis of glenohumeral joint who underwent a Total Shoulder Arthroplasty (TSA). Four measures [Western Ontario Osteoarthritis Shoulder (WOOS) Index, the American Shoulder and Elbow Surgeon’s (ASES) assessment, Constant-Murley Score (CMS), and Quick Disabilities of the Arm, Shoulder, and Hand (QuickDASH)] were completed 2-3 weeks before surgery and at 6 months after surgery. The measurement properties were examined in: 1) internal consistency as a measure of reliability, 2) cross-sectional and longitudinal convergent validity, 3) known group validity, and 4) sensitivity to change at 6 months following surgery. Analysis involved calculating Cronbach Coefficient Alpha to measure internal consistency. Convergent validity was examined by the Pearson correlation coefficient. Analysis of Variance examined the extent of known group validity. The Standardized Response Mean (SRM) was used to measure the relative sensitivity to change.

**Results:** Seventy patients (mean age: 65, range: 35-86, 44 females, 26 males) participated in the study. The Cronbach Coefficient Alpha was high at 0.91, 0.86, and 0.83 for WOOS, ASES, and QuickDASH respectively. Cross-sectional convergent validity was moderate with correlations varying from 0.54 to 0.79. Longitudinal convergent validity ranged from 0.58 to 0.88. All measures were able to discriminate between men and women at p<0.05 with Cohen’s d of 1.07, 0.85, 0.82, and 0.55 for QuickDASH, CMS, WOOS, and ASES respectively. The SRM was 2.41, 2.17, 1.88, and 1.63 for WOOS, CMS, ASES and QuickDASH respectively.

**Conclusion:** All four disability measures were valid and reliable in candidates for TSA. The WOOS, a disease-specific outcome demonstrated a higher reliability and sensitivity to change than other measures. QuickDASH had a better ability to differentiate between men and women. Clinicians may not gain additional information by administering multiple similar outcome measures. Researchers will decrease their chance of declaring a statistical significance by choosing one primary outcome measure.

177 - An Examination of Inter- and Intra-Rater Reliability of Shoulder Radiographs among Patients with Recurrent Instability Requiring Surgical Correction

Martin J Bouliane, AB; David M Sheps, AB; Holman Chan, AB; Robert M Lambert, AB; Robert Glasgow, AB; Kyle A Kemp, AB;

**Purpose:** The Instability Severity Index Score (ISIS) is a 6-item questionnaire that has been reported to predict failure of arthroscopic Bankart repair among patients treated for recurrent anterior glenohumeral instability. Two of the ISIS items pertain to radiographic features (presence of a Hill-Sachs lesion, loss of glenoid contour). These, however have yet to be validated. The goal of this study was to examine the inter- and intra-rater agreement and corresponding reliability of the radiographic aspects of the ISIS.

**Method:** Fifty-two plain, randomly selected, true antero-posterior radiographs in 45° gleno-humeral external rotation were evaluated by five assessors (three upper extremity orthopaedic surgeons, one senior orthopaedic resident and one musculoskeletal radiologist). Radiographs were retrieved for patients with documented recurrent shoulder instability requiring surgical stabilization and placed in a blinded Microsoft PowerPoint presentation for evaluation. Assessors were asked to determine the presence/absence of a Hill-Sachs lesion and if a loss of glenoid contour was present. Radiographs were evaluated in random order on two occasions, separated by a one-week time interval. Intra- and inter-rater reliability was assessed using percentage of agreement and kappa statistics.

**Results:** For session one, the number of Hill-Sachs lesions observed among raters ranged from 11 to 32. This resulted in inter-rater agreement ranging from 48% to 78% (k = 0.07 to 0.42), indicating poor to fair reliability. Cases with loss of glenoid contour ranged from seven to 14 with inter-rater agreement of 66% and 90% (k = 0.01 to 0.61), suggesting poor to moderate reliability. Session two led to modest increases in inter-rater agreement. The number of Hill-Sachs lesions observed ranged from four to 30 (agreement of 48% to 84%; k = 0.11 to 0.60) indicating fair to moderate reliability and the number of cases with loss of glenoid contour ranged from three to 14 (agreement of 66% to 94%; k = -0.04 to 0.69), ranging from poor to moderate reliability. With respect to intra-rater reliability, agreement ranged from 71% to 94% (k = 0.41 to 0.86) for Hill-Sachs lesions, indicating fair to good reliability and 76% to 94% (k = 0.20 to 0.74) for loss of glenoid contour, ranging from fair to good reliability. Intra-rater agreement and corresponding kappa values were highest among the upper extremity surgeons and the musculoskeletal radiologist, particularly for loss of glenoid contour (85% to 94%; k = 0.56 to 0.74) suggesting there is moderate to good reliability in this measurement.

**Conclusion:** Our results indicate that the intra-rater reliability of the ISIS radiographic features was highest among upper extremity specialists and the musculoskeletal radiologist, suggesting that the ISIS may have utility in an experienced clinician’s individual
practice. As the inter-rater reliability appears low, particularly for Hill-Sachs lesions, its wide-spread use across surgeons should be examined in further research.

178 - Strain in Glenoid Bone in Total Shoulder Arthroplasty: an in-vitro study
R Andrew Glennie, ON; Joshua W Giles, ON; Louis M Ferreira, ON; George S Athwal, ON; James Johnson, ON; Kenneth Faber, ON; Ryan T Bicknell, ON; Alex Bertelsen, US; Frederick Matsen, US

Purpose: Glenoid component loosening is a common reason for failed total shoulder arthroplasty. Multiple factors have been suggested as causes for component loosening including asymmetric loading of the glenoid prosthesis by the humeral head (rocking horse phenomenon). A novel technique was employed to measure in-vitro strain in the subchondral bone adjacent to a cemented all polyethylene pegged glenoid prosthesis. The purpose of the study was to develop and validate a testing protocol to investigate load transfer in the polyethylene glenoid implant and bone construct.

Method: Eight polyethylene components were implanted using standard cementing techniques in eight cadaveric specimens. Loading was performed with a pneumatic actuator capable of applying loads at various angles. A dynamic 10 N/s force was applied for a total of 15 seconds producing a maximum force of 150N at angles of 0, 10, 20, 30, 40 and 50o. Strain gauges were placed around the implant 1mm proximal to the bone-cement interface at the four quadrants. The humeral head was simulated with a custom steel ball with a non-conforming diameter in relation to the prosthesis that is typical in total shoulder arthroplasty.

Results: During pure compressive loading, tension was observed in the superior and inferior quadrants of the glenoid. Superior and inferior loading caused increasing same side (ipsilateral) tension, occurring from 0 to 30o and 0 to 20o, respectively. Compression was recorded superiorly when loading was applied at 40o and 50o in the superior direction while contralateral tension was recorded in the inferior gauges. Strain measurements were less consistent in the anterior and posterior glenoid quadrants and varied between tension and compression.

Conclusion: Tension measurements in the ipsilateral direction at lower angles were unexpected. This observation differs from the previous assumption that applied loads at relatively perpendicular angles to the implant should dissipate as compression. Tension at the bone cement interface is unfavorable. The identification of tension in some quadrants of the implant in this study, therefore, may have revealed a mechanism of implant loosening. Our data support the previously described rocking horse phenomena and also illustrate a new umbrella type effect of polyethylene flexure, which causes tension in the periphery of the glenoid implant to flex upwards superiorly and inferiorly. These findings have the potential to influence future designs of total shoulder arthroplasty perhaps leading to increased implant survival.

179 - Factors Affecting Stability of the Reverse Total Shoulder Arthroplasty
Ryan T Bicknell, ON; Alex Bertelsen, US; Frederick Matsen, US

Purpose: The objectives of this study were: 1) to determine if the deltoid, conjoint tendon and long head of the triceps provide sufficient soft tissue tension to stabilize a RTSA, and; 2) to determine the influence of loading direction, arm rotation, shoulder position and polyethylene thickness on stability of a RTSA. The hypotheses were: 1) that the deltoid, conjoint tendon and long head of the triceps provide sufficient soft tissue tension to stabilize a RTSA, and; 2) that arm rotation, shoulder position and loading direction would affect stability and increased polyethylene thickness would be associated with increased stability.

Method: Methods: Six cadaveric shoulders had all capsule, rotator cuff, and scapulohumeral muscles removed, leaving only the deltoid, conjoint tendon (i.e. coracobrachialis and short head of biceps) and long head of triceps. A RTSA was then performed. A displacing force was then applied perpendicular to the centerline of the humeral socket and this load was increased until dislocation occurred. The load required to cause a dislocation was recorded for superior, inferior, anterior and posterior loading directions. This was repeated to measure the effect of humeral component rotation (neutral, 20 degrees retroversion, 20 degrees anteverision), arm position (0 degrees abduction, 60 degrees flexion, 60 degrees abduction and 60 degrees extension) and polyethylene thickness (3, 6 or 9 mm). Statistical analysis used an ANOVA with Tukey post-hoc tests for multiple comparisons (p< 0.05).

Results: Results: The deltoid, conjoint tendon and long head of the triceps provide sufficient soft tissue tension to stabilize a RTSA. The required dislocation force was increased for an inferior direction of load application (p<0.05). The required dislocation force was least in an arm position of 60 degrees abduction, followed by 60 degrees extension, with no difference between 0 degrees abduction and 60 degrees flexion (p0.05).

Conclusion: Conclusions: The deltoid, conjoint tendon and long head of the triceps provide sufficient soft tissue tension to stabilize a RTSA. Stability of a RTSA was greatest for an inferior directed force and an arm position of 0 degrees abduction or 60 degrees flexion. There was no influence of arm rotation or polyethylene thickness on stability of a RTSA. This study indicates that stability of a RTSA can still be achieved despite significant soft tissue loss, as long as key soft tissue structures remain intact. As well, certain loading directions and arm positions lead to an increased risk of instability. However, further in vivo studies are required.

180 - The Medial Calcar is Directly Correlated with Humeral Head Version : A CT-based Study
Daniel P Goel, US; George S Athwal, ON; Joy Macdermid, ON

Purpose: The success of humeral head replacement following fracture is reliant on several factors, one of which is version. The correct humeral version (HV) is highly variable, and is patient and side dependent. In the setting of fracture, there is no intra-operative landmark to guide the surgeon as to the anatomic version. This study has examined computed tomography (CT) of the shoulder and compared the HV to the metaphyseal version (MV) to evaluate reliability in predicting the anatomic version.
Method: A retrospective review of 50 shoulder CT scans was carried out. Patients were excluded if the anatomy prevented HV or MV evaluation. The HV and MV was measured by 2 independent evaluators. Inter and intrarater reliability was performed.

Results: There were 27 right and 23 left shoulder CT’s reviewed. The mean age of patients was 45.3 (range 13-85). The difference between the MV and HV was approximately 2.8 (95% CI 0.63-5.1). Inter and intra-rater reliability was 0.966 and 0.984, respectively.

Conclusion: Determining the version of the humeral head in the setting of fracture is difficult and highly inaccurate. The biceps groove has been previously cited as a landmark for arthroplasty position, however, given the anatomic variability, version may be miscalculated. We have demonstrated the medial calcar of the proximal humerus is within 3 degrees of the actual humeral head version. This CT guided approach is novel, reproducible and demonstrates excellent reliability. It is both accurate and consistent and may be successfully utilized in the setting where normal anatomic landmarks are absent, such as fracture.

Paper Session #20 COA Education

181 - A Comparison of Orthopaedic Residents’ Performance on the Surgical Fixation of an Ulna Fracture Using Virtual Reality and Sawbones Simulators
Justin M LeBlanc. AB; Carol Hutchison, AB; Manar Din Samad, AB; Aron Su, AB; Antoine Widmer, AB; Yaoping Hu, AB; Tyrone Donnon, AB;

Purpose: Surgical trainees develop psychomotor skills using various techniques, with simulators providing safe practicing environments. There has been no development of virtual simulators with haptics (force feedback) that allow residents to practice the open surgical fixation of common orthopedic fractures. The main purpose of this study was to assess if residents performed similarly on a newly developed virtual simulator as on a Sawbones simulator using a modified checklist and global rating scale. Secondary purposes were to assess the reliability and validity of these procedural measurement tools.

Method: A stratified randomized within-subjects study was performed with 22 surgical trainee volunteers. They were randomized to first perform surgical fixation of the ulna using either the virtual or Sawbones simulator, and then performed the same procedure on the other simulator. Evaluators completed a task-specific checklist, global rating scale (GRS), total error score and time to completion for each participant on both simulators.

Results: The participants achieved significantly better scores on the virtual simulator compared to the Sawbones simulator (p<0.8), except in time to completion. When combined, the checklist and GRS maintained high levels of internal consistency (Cronbach’s α >0.80) and inter-rater reliability (intraclass coefficient >0.90) for both simulators. A Pearson’s product moment correlation was used to demonstrate criterion validity of the measurement tools. They were all significantly correlated to each other within simulators (p<0.9), while the virtual simulator achieved construct validity for the GRS and total error score (p<1.1).

Conclusion: The modified procedural measurement tools demonstrate reliability and validity and the virtual simulator shows evidence of construct validity. These tools were used to evaluate participants, demonstrating the achievement of better scores on the virtual simulator compared to the Sawbones simulator. The only concern at this time is that the procedural measurement tool scores do not correlate between simulators. The newly developed virtual ulna surgical fixation simulator with haptics shows promise for helping surgical trainees learn and practice basic skills, but requires further modifications before it can attain the same standards as the current gold standard simulators.

182 - The Measurement of Changes in the Self-perceived Confidence of Orthopaedic Trainees After an Arthroscopic Skills Course
Jesse A Shantz, MB; Jeffrey Leiter, MB; Sheila McRae, MB; Peter B MacDonald, MB;

Purpose: The development of confidence in the operating room is a major goal of surgical training. Confidence in surgery involves trusting information, intuition and experience. Confidence can also be detrimental when it impedes the ability to self-assess skills and decision-making. The measurement of confidence is difficult owing to the sequential acquisition of information and experience. The following study examines the trends in self-reported confidence in residents participating in cadaveric arthroscopic courses.

Method: In 2007 and 2008 residents participating in annual arthroscopic courses at the returned pre-course and post-course questionnaires recording previous arthroscopic exposure. Participants had access to fresh-frozen cadaver specimens and arthroscopic instruments for five hours after didactic lectures. Each participant rated perceived confidence and skill on a five-point Likert scale before and after the course. Mean confidence was compared using a student’s t-test. Data were further analysed using linear regression of pre- and post-course Likert scores.

Results: Residents showed a significant increase in self-perceived confidence in the performance of meniscal repair, anterior cruciate ligament reconstruction and labral repair and subacromial decompression directly after an arthroscopy course (p<0.01). Regression analysis yielded a y-intercept not significantly different from zero prior to the course with a significant increase in the intercept after the course. There was no significant difference in the relationship of increasing arthroscopic experience to training noted as a result of the course.

Conclusion: Novice residents appeared to gain more self-reported confidence than experienced residents following an arthroscopic skills course. Future courses should consider the separation of novice and experienced residents to focus on improving the self-
perceived confidence of experienced residents while exposing novice residents to the complexities of arthroscopic techniques. More research is needed to increase the understanding of the effects of confidence on trainees at various stages of training.

183 - Prevalence of Abuse and Intimate Partner Violence Surgical Evaluation (P.R.A.I.S.E.): A Cross-sectional Study at Two Fracture Clinics in Ontario
Emil H Schemitsch, ON; Mohit Bhandari, ON; PRAISE Investigators, ON;

**Purpose:** Intimate partner violence (IPV), also known as domestic violence, is a pattern of coercive behaviors that include repeated physical, sexual and emotional abuse. Musculoskeletal injuries are common manifestations of IPV. We aimed to determine the proportion of women presenting to orthopaedic fracture clinics for treatment of orthopaedic injuries that have experienced IPV defined as physical, sexual, or emotional abuse within the past 12 months.

**Method:** We completed a cross-sectional study of 282 injured women attending two Level I trauma centres in Canada. Female patients presenting to the orthopaedic fracture clinics completed two validated self-reported written questionnaires (Woman Abuse Screening Tool (WAST) and the Partner Violence Screen (PVVS)) to determine the prevalence of IPV. The questionnaire also contained questions that pertain to the participant’s demographic, fracture characteristics, and experiences with health care utilization.

**Results:** The overall prevalence of IPV (emotional, physical, and sexual abuse) within the last 12 months was 32% (95% Confidence Interval 26.4% to 37.2%) (89 of 282 women). One in 12 injured women disclosed a history of physical abuse (24/282, 8.5%) in the past year. Seven women (2.5%) indicated the cause for their current visit was directly related to physical abuse, of which five were fractures. We did not identify any significant trends in ethnicity, socioeconomic status, or injury patterns as markers of domestic abuse. Of 24 women with physical injuries, only four had been asked about IPV by a physician, none of whom were their treating orthopaedic surgeons.

**Conclusion:** Our study confirms a high prevalence of IPV among female patients with injuries attending orthopaedic surgical clinics in Ontario. Similar to previous research our study found that women of all ages, ethnicities, social economic status, and injury patterns may experience IPV. Surgeons should consider screening all injured women for domestic violence in their clinics.

184 - Help versus Harm? The Effect of Training Femoral Neck Screw Insertion Skills to Surgical Trainees with Computer-assisted Surgery: Comparison to Conventional Fluoroscopic Technique
Markku T Nousiainen, ON; Patrick Zingg, CH; Daniel Omoto, NS; Heather Carnahan, ON; Yoram Weil*, IL; Hans Kreder, ON; David L Helfet, US;

**Purpose:** This study attempted to determine if the form of feedback provided by a computer-based navigation technique improves the learning of the placement of cannulated screws across a femoral neck fracture in the surgical trainee.

**Method:** A prospective, randomized, appropriately powered, and controlled study involving 39 surgical trainees (first-year residents and fourth-year medical students) with no prior experience in surgically managing femoral neck fractures were used in the study. After a training session, participants underwent a pretest by performing the surgical task on a simulated hip fracture using fluoroscopic guidance. Immediately after, 20 participants were randomized into undergoing a training session using a conventional fluoroscopy-guided technique while the other participants were randomized into undergoing a training session using a computer-based navigation technique. Immediate post-tests and retention tests (4 weeks later) were performed. A transfer test was used to assess the impact of the type of training on surgical performance – after performing the retention test, each group repeated the task but used the other technique to guide them (i.e. those trained with fluoroscopy used computer navigation and vice versa).

**Results:** Screw placement was equal and to the level of an expert surgeon with either training technique during the post-, retention, and transfer tests. Participants that were trained with computer navigation took fewer attempts to position hardware and used less fluoroscopy time than those that trained with fluoroscopy. When participants that trained with computer navigation reverted to conventional fluoroscopic technique at the transfer test, more fluoroscopy time and dosage was used. Participants that trained with fluoroscopy used less fluoroscopy time and took fewer attempts to position hardware when they subsequently used computer navigation to perform the task during the transfer test.

**Conclusion:** Computer navigation does not harm the learning of surgical novices in this basic orthopaedic surgical skill. Training with computer navigation minimizes radiation exposure and decreases the number of attempts to perform the task. No compromise in learning occurs if a surgical novice trains with one type of technology and transfers to using the other.

185 - Revised Title: Quality of Life and Educational Benefit Among Orthopaedic Surgery Residents: A Prospective, Multi-centre Comparison of the Night Float and the Standard Call Systems
Ali Zahrai, ON; Jaskarndip Chahal, ON; Dan Stojsimirovic, ON; Albert Yee, ON; Emil H Schemitsch, ON; William Kraemer, ON;

**Purpose:** Given recent evolving guidelines regarding maximum allowable work hours and emphasis on resident quality of life, novel strategies are required for implementing call schedules. The night float system has been used by some institutions as a strategy to decrease the burden of call on resident quality of life in level one trauma centres. The purpose of this study was to determine whether there are differences in quality of life, work-related stressors, and educational experience between orthopaedic surgery residents in the night float and standard call systems at two level one trauma centres.

**Method:** This was a prospective cohort study at two level one trauma hospitals comprised of a standard call (1 in 4) group and a night float (5pm-7am, Sunday to Friday) group for each hospital, respectively. Residents completed the Short Form 36 (SF-36) general
quality-of-life questionnaire, as well as, questionnaires on stress level and educational experience before the rotation (baseline), at two, four and subsequently at six months. An analysis of covariance (ANCOVA) approach was used to compare between-group differences using the baseline scores as covariates. Wilcoxon Signed-Rank tests (non-parametric) were used to determine if the residents’ SF-36 scores were different from the age and sex matched Canadian norms. Predictors of resident quality of life were analyzed using multivariable mixed models.

**Results:** Seven residents were in the standard call group and nine in the night float group for a total of 16 residents (all males, mean age=35.1 yrs). Controlling for between-group differences at baseline, residents on the night float rotation had significantly lower role physical (RP), bodily pain (BP), social function (SF) subscale scores (p<0.05).  

**Conclusion:** Our study suggests that the residents in the standard call group had better health related quality of life in comparison with the night float group. No differences existed in subjective educational benefits and stress level between the groups. The study findings may be limited due to the small sample size. However, this sample size is substantial given the size of most orthopaedic residency programs in North America.

### 186 - Core Competencies Important for Canada's Graduating Orthopaedic Surgeon

**Veronica M Wadey,** ON; Parvati Dev, US; Richard Buckley, AB; Douglas Hedden, ON;  

**Purpose:** The RCPSC Orthopaedic Specialty Committee for Residency Training and the Examination Committee for Orthopaedic Surgery requested that work be completed to assist with identifying competencies that should be included in a core curriculum for graduating orthopaedic surgery residents in Canada. The purpose of this study was to determine competencies to be of greatest importance by orthopaedic surgeons whose primary affiliation was non-university, for the purpose of developing a core curriculum in orthopaedic surgery for graduating residents within Canada.

**Method:** A 281-item list of competencies was developed consisting of three sections: a previously validated curriculum for musculoskeletal health, Orthopaedic Specialty objectives of the Royal College of Physicians and Surgeons of Canada, curricula representing orthopaedic programs from accredited academic orthopaedic programs within Canada and, a comprehensive procedure list. Competencies were compared to existing curricula within Canada. A content review was completed and a modified questionnaire was developed. A stratified, randomized selection of, non-university, orthopaedic surgeons rated each individual item on an integer scale 1 to 4 of increasing level of importance. Summary statistics across all respondents were given. Average mean scores and standard deviations were computed. Secondary analyses were computed in general, paediatrics, trauma and adult reconstruction.

**Results:** 131/156 (84 %) of orthopaedic surgeons participated. 240/281 competencies (85.4%) were rated average scores of at least 3.0 suggesting probably important or important to demonstrate competency by completion of training. 41/281 items (15.6%) were given average scores between 2.0 and 2.93 thus suggesting not important.

**Conclusion:** This study identified competencies necessary for a Core Curriculum for Orthopaedic Surgery. Complex procedures in various categories and content considered less essential for orthopaedic surgeons were rated to be less important. How curriculum is ultimately structured, delivered and implemented needs to be studied. We know that learning activities are "driven” by the evaluation of competencies. Is competency-based education on the horizon or should we be focused on assessing competencies within the current method of curriculum delivery?

### 187 - Understanding the “Personality” of the Associated-both-Column Acetabular Fracture using Visuo-haptic Feedback

**Markian A Pahuta,** ON; Emil H Schenitsch, ON; David Backstein, ON; Steven Papp, ON; Wade Gotfot, ON;  

**Purpose:** Preoperative planning forces the surgeon to understand the "fracture personality" and devise an operative plan. In our experience, trainees have difficulty in preparing for complex acetabular cases; these fractures are among the most difficult fractures to conceptualize and teach. As a result, these fractures are poorly understood as demonstrated by low interobserver agreement between trainees in the classification of acetabular fractures. We sought to determine whether the use of visuo-haptic technology would help trainees to appreciate the “personality” of an Associated-Both-Column (ABC)fracture more accurately than trainees taught by conventional instruction.

**Method:** Thirty senior medical students and PGY1 residents, were randomized into two groups. The control group studied an ABC fracture with the aid of a textbook excerpt and a 3D CT reconstruction of the fracture. The intervention group was given the same instructional materials, and a visuo-haptic CT model of the fracture. All other learning variables, including time on task were standardized. Participants were evaluated on their accuracy in drawing the fracture lines on a model pelvis.

**Results:** There was no significant difference in gender, visuo-spatial ability, and training level between groups. The participants taught with the visuo-haptic model recalled an additional 26% anatomic relationships (p<0.01) compared with the control group.

**Conclusion:** These findings suggest that in addition to the benefits observed in the learning of motor skills, visuo-haptic input may improve the understanding of spatial relationships. This technology may be a useful adjunct for teaching anatomy, as well as preoperative planning.

### 188 - Spine Surgery Core Curriculum: A Review of Competencies in Subspecialty Fellowship Training

**Harsha Malempati,** ON; Veronica Wadey, ON; David Backstein, ON; Hans Kreder, ON; Scott Paquette, BC; Eric Massicotte, ON; Albert Yee, ON;
**Purpose:** To evaluate fellowship trainee and supervisor perceptions on the relative importance of core cognitive and procedural competencies in spine subspecialty fellowship training.

**Method:** A questionnaire was designed through synthesis and amalgamation of two previous surveys designed by other authors. This questionnaire was reviewed for content by spine surgery experts (Canadian Spine Society Education Committee). The questionnaire was administered (online and paper) to fellow trainees and supervisors across Canada and data was collected over a 3-month period. It consisted of 40 MCQ items grouped into 13 broad cognitive skills categories, as well as 29 technical/procedural items. Data was analyzed using qualitative and descriptive statistics (e.g. average mean scores, standard deviations, t-tests).

**Results:** The response rate was 91%, with 15 of 17 fellow trainees and 47 of 51 supervisors completing the survey. Twelve of the 13 core cognitive skill categories were rated as being important to acquire by the end of fellowship. Trainees were not comfortable performing, and requested additional training in 8 of 29 spine surgery technical skill items. Specifically, additional training was believed to be required for intradural procedures (e.g. syringomyelia, intradural neoplasms) and other less common, technically demanding, procedures (e.g. transoral odontoidectomy, anterior thoracic discectomy). Significant differences (p<0.05) existed in perceptions of importance for specific cognitive and technical skills based on previous residency training (orthopaedic or neurosurgical). No such differences were found when comparing responses of the fellow trainees and their supervisors.

**Conclusion:** This study demonstrates that fellow trainees and supervisors have similar perceptions on the relative importance of specific core cognitive and procedural competencies required in achieving successful spine fellowship training. Furthermore, background specialty training (orthopaedic or neurosurgical) influences the perceptions of both fellow trainees and supervisors regarding the importance of specific cognitive and technical skills deemed necessary for successful training.

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**189 - Quality Reporting: Trials Lack Citations of Indices and Scales to Assess Disability**

**Amy M Hoang-Kim,** ON; Mohit Bhandari, ON; Dorcas E Beaton, ON; Emil H Schemitsch, ON;

**Purpose:** Today, numerous functional outcome tools exist to assess the patient's ability to carry out basic and instrumental activities of daily living. Furthermore, the increase in range of mobility measures reflect differences in rating scales, scores, administration and scoring options which make outcome results difficult to assess across trials. Because of the lack of consensus among investigators, we wanted to identify the citation patterns of the functional outcomes tools used by investigators in hip fracture RCTs. We believed that the lack of proper citation is an underlying factor in the diverse usage of outcome tools.

**Method:** We extracted the citations of disability tools from 59 Level 1 hip fracture RCTs. Disability was defined using the WHO classification (ICF). We excluded measures assessing body structure. The text and reference lists of the identified articles were screened in order to compile relevant literature on the instrument used in the RCT. Disability tools which were cited in the references were also compared to original development articles.

**Results:** Overall 68 different instruments were identified that measured disability in the hip fracture literature. According to ICF, 47 tools measured body function alone, 13 tools evaluated activity limitations and participation restriction and 8 were composite scoring systems. We found that 34.2% of the trials did not provide any citations to the tools assessing body function. In trials measuring activity and participation, 23.2% provided instrument citations. In trials using composite scoring systems, 19.4% of the trials provided instrument citations. All of the instrument citations when provided by the investigators were found to correspond to original development articles or trials.

**Conclusion:** The appropriate choice of a functional outcome instrument is fundamental in order to ensure that the results that are obtained reflect the patient. However, if citations of the indices and scales themselves are lacking, trial methodology and results could be informative but not replicated. In the future, we recommend that rigor in quality reporting include proper instrument citations.

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**190 - Surgical Simulators and Hip Fractures: A Role in Residency Training?**

**John M Froelich,** US; Joseph C Milbrandt, US; D Gordon Allan, US;

**Purpose:** Orthopaedic residency training requires intellectual and motor skill development. In this study we aim to develop a model to evaluate junior resident proficiency and efficiency versus senior residents in the placement of a center-center guidewire during fixation of an intertrochanteric proximal femur fracture utilizing a computer-based haptic simulator. We hypothesize the junior residents will utilize more fluoroscopy and require more time to complete the task.

**Method:** Post-graduate year residents (PGY) 3-5s, labeled Group II, placed a single central guide pin into a femoral head utilizing a surgical simulator four times. PGY 1-2s, labeled Group I, completed the same task six times. The residents were then evaluated based on final tip-apex distance (TAD), fluoroscopy time, time to complete the task, total number of distinct attempts at pin placement for each femur construct as well as final three-dimensional location of the pin from the isometric center of the femoral head. This project was approved by the institutional IRB.

**Conclusion:** In this study we displayed that based on our simulator model there was no statistical difference between Group I and II in time to completion, final placement on AP view, and tip-apex distance. There was a statistically significant difference in the anterior/posterior placement of the wire between the two groups, fluoroscopy time, and number of attempts per trial. Our findings suggest a computer based surgical simulator can identify measurable differences in surgical proficiency between junior and senior orthopaedic residents.
**191 - Radiologic Assessment of Lumbar Spine Fusion: Is it (Con)fused?**

**Christina Goldstein, ON; Stephen Petis, ON; Marcin Kowalczuk, ON; Brian Drew, ON; Brad Petrisor, ON; Mohit Bhandari, ON;**

**Purpose:** A lack of consensus regarding the radiologic criteria to diagnose spinal non-union limits inferences from clinical research. This systematic review aimed to examine the spectrum of radiologic investigations used to assess lumbar spinal fusion and the definitions of successful spine union used in the spine literature.

**Method:** We comprehensively searched three electronic databases from 1950 to 2009 (MEDLINE, Embase and the Cochrane Central Register of Controlled Trials) for clinical studies involving posterolateral fusion of the lumbar spine. English-language studies including adult patients and reporting a definition of successful fusion were included. Studies examining the reliability and validity of radiologic investigations were also identified. Key measures included 1) radiologic investigations, 2) definition of successful lumbar fusion and 3) reliability, sensitivity and specificity of the investigations used to assess the spinal fusion.

**Results:** Among 1165 potentially eligible studies, 91 met our inclusion criteria. Of the studies 78% (n = 71) used plain radiographs to diagnose non-union, 4% (n = 4) used CT scans and 18% (n = 16) used both. Fifty-one studies used both static (x-ray or CT) and dynamic (flexion-extension x-ray) images, 35 used only static images and five used only dynamic radiographs. In total, we identified fifty-two different radiographic definitions of successful fusion. More than half of the studies (n = 50, 55%) failed to provide a reference for the definition used. The most common definition of fusion (7 studies) used static radiographs and defined fusion as continuous intertransverse bony bridging with this quality of fusion at all intended levels. Seven studies evaluated reliability of x-ray criteria but no studies provided complete validation of the definitions. Only 3 studies provided some validation and reliability estimates of thin-slice CT scanning in diagnosing spinal non-union. Significant variability in reliability, sensitivity and specificity exists for all radiologic investigations in the diagnosis of spinal non-union.

**Conclusion:** The radiologic investigations and definitions of successful posterolateral fusion used in the spine literature vary substantially. Choice of radiologic criteria should be based upon reliability and validity testing. Studies using fusion criteria that have not been shown to be reliable or valid should be interpreted with caution.

**192 - Introducing a New Health Related Quality of Life Outcome Tool for Metastatic Disease of the Spine. Content Validation Using the International Classification of Functioning, Disability and Health**

**John Street, BC; Brian Lenehan, BC; Charles Fisher, BC;**

**Purpose:** A systematic review of Health Related Quality of Life Outcomes (HRQOL) in metastatic disease of the spine and content validation of a new Spine Oncology Study Group Outcomes Questionnaire (SOSGOQ). To identify HRQOL questionnaires previously reported for spinal metastases and to validate the content of the new SOSGOQ based on the International Classification of Function and disability (ICF).

**Method:** A systematic review identified 141 studies. Reported outcome tools were enumerated. The most commonly utilized (ESAS, Karnofsky Scale and ODI) and the SOSGOQ were linked to the ICF. Descriptive statistics examined the frequency and specificity of the ICF linkage. Linkage reliability was evaluated by inter-investigator percentage agreement.

**Results:** The SOSGOQ contains 56 concepts, with all 4 domains of the ICF represented. 4 concepts could not be linked. There was 100% inter-observer agreement (IOA) for total number of concepts and for those ‘not covered’. 100% of concepts had ‘First and Second’ level linkage. 100% IOA exists at both ‘Component’ and ‘First Level’ linkage. There was 96.1% IOA at ‘Second’ Level. 33 concepts linked to Third Level with 96.9% IOA. 10 concepts linked at the Fourth Level with 100% IOA.

**Conclusion:** The SOSGOQ includes all domains relevant for measurement of function and disability and its content validity is confirmed by linkage with the ICF. This new questionnaire has superior content capacity to measure disease burden of patients with metastatic disease of the spine than any instruments previously identified in the literature.

**193 - CT and MRI for Assessment of Degenerative Lumbar Spinal Stenosis: Is MR Superior to CT?**

**Christopher S Bailey, ON; Khalid Alsaleh, ON; Derek Ho, ON; Patricia Rosas-Arellano, ON; Stewart I Bailey, ON; Kevin R Gurr, ON;**

**Purpose:** Magnetic resonance imaging (MRI) and Computerized tomography (CT) are commonly used for the diagnosis and assessment of lumbar spinal stenosis. The available literature has not identified which modality is superior. We compared the reliability and accuracy of CT and MRI in the assessment of lumbar spinal stenosis.

**Method:** We performed a prospective review of CT and MRI scans of 54 patients referred for surgical consultation. One orthopaedic spine fellow and one neuro-radiologist reviewed the CTs and MRIs. A qualitative and quantitative analysis was performed. Intra-observer and inter-observer reliability was determined using Kappa coefficient. The patient’s official reports were correlated with analysis performed by the two reviewers. Oswestry and SF-36 data was correlated with the qualitative and qualitative assessment of stenosis on CT, MRI using the Pearson’s R coefficient.

**Results:** MRI - substantial inter-observer agreement was achieved between surgeon and neuro-radiologist as well as between surgeon and reporting radiologist (κ= 0.74 and κ=0.64 respectively). Moderate agreement was found between neuro-radiologist and reporting
radiologist (κ=0.57). Almost perfect intra-observer reliability for MRI was achieved by the two expert reviewers (κ=0.91 for surgeon and κ=0.92 for neuro-radiologist). CT - moderate inter-observer agreement (κ=0.58) was found between surgeon and neuro-radiologist. Fair agreement was found between neuro-radiologist and reporting radiologist and between surgeon and reporting radiologist (κ=0.30 and 0.32 respectively). Substantial intra-observer agreement was found for the surgeon (κ=0.77) while the neuro-radiologist achieved almost perfect agreement (κ=0.96).

Conclusion: This study directly demonstrates that MRI is likely a more reliable tool than CT, but neither correlates with functional status.

194 - Spinal Column and Spinal Cord Injuries in Mountain Bikers: A Thirteen-Year Review
Emily R Dodwell, BC; Brian Kwon, BC; Barbara Hughes, BC; David Koo, BC; Andrea Townson, BC; Allan Aludino, BC; Richard Simons, BC; Charles Fisher, BC; Marcel Dvorak, BC; Vanessa Noonan, BC;

Purpose: Multiple studies have described the general injuries associated with mountain biking. However, no detailed assessment of mountain biking associated spinal column fractures and spinal cord injuries (SCI) has previously been reported. The purpose of this study is to describe the patient demographics, injuries, mechanisms, treatments, outcomes and resource requirements associated with spine injuries sustained while mountain biking.

Method: Patients who were injured while mountain biking, and presented to a provincial spine referral centre between 1995 and 2007 inclusive, with SCI and/or spine fracture were included. A chart review was performed to obtain demographic data, and details of the injury, treatment, outcome and resource requirements.

Results: 102 men and 5 women were identified for inclusion. The mean age at injury was 32.7 years 95%CI[30.6,35.0]. 79 patients (73.8%) sustained cervical injuries, while the remainder sustained thoracic or lumbar injuries. 43 patients (40.2%) sustained a SCI. Of those with cord injuries, 18(41.9%) were ASIA A, 5(11.6%) were ASIA B, 10(23.3%) ASIA C, and 10(23.3%) ASIA D. 67 patients (62.6%) required surgical treatment. The mean length of stay in an acute hospital bed was 16.9 days 95%CI[13.1,30.0]. 33 patients (30.8%) required ICU care, and 31 patients (29.0%) required inpatient rehabilitation. Of the 43 patients (39.6%) who presented with SCI, 14(32.5%) improved by one ASIA category, and 1 (2.0%) improved by two ASIA categories. Two patients remained ventilator-dependent at discharge.

Conclusion: Spine fractures and SCI due to mountain biking accidents typically affect young, male, recreational riders. The medical, personal, and societal costs of these injuries are high. Injury prevention should remain a primary goal, and further research is necessary to explore the utility of educational programs, and the impact of helmets and other protective gear on spine injuries sustained while mountain biking.

195 - 3D Spine Morphologic Differences at First Visit Between Non-evolutive and an Evolutive Adolescent Idiopathic Scoliosis
Marie-Lyne Nault, QC; Stefan Parent, QC; Marjolaine Roy-Beaudry, QC; Jacques A de Guise, QC; Hubert Labelle, QC;

Purpose: Prediction of progression is actually impossible in adolescent idiopathic scoliosis (AIS). Potential risk factor to consider at first visit might be morphologic parameters of the spine. The objective of this study was to compare 3D morphologic parameters of the spine in a non evolutive an in an evolutive group of AIS.

Method: A retrospective cohort study was done. Two groups were recruited with sample size based on a difference of 5 degrees for rotation parameters. First group were all surgical patients (n=19) and second group non evolutive patient (n=18). Inclusion criteria were (1) Risser sign of 0 or 1 (2) Cobb angle between 11 and 40 degrees (3) AP and lateral radiograph available. Exclusion criteria were (1) limb length discrepancy (2) syndromic or congenital scoliosis. All spines were reconstructed in 3D with AP and lateral radiographs. Student t test were performed.

Results: There was no statistical difference between the two groups for Cobb angle in maximal plane, for lordosis and kyphosis. Differences were found for wedging of the apical disk in 3D plane (S=5,4° vs NE= 0,7° with p=0.04). For coronal orientation of the apex (S=7,8° vs NE=0,1° with p=0.01). For axial orientation of inferior junctional vertebrae (S=1,9° vs 0,1° with p=0.007). For torsion (S=-4,1° vs NE= -1,2° with p=0.03). For ratio between height and width of T6 (S=51% vs NE=53,6% with p=0.04).

Conclusion: This study give for the first time some 3D morphologic parameters that could be use in the prediction of AIS. Some limitations exist such as the small sample size and the low level of significance. In the future those parameters will be used in the development of a prediction model base on those keys parameters that will confirm the actual findings.

196 - Electrical Stimulation in Spine Fusion: A Meta-analysis of Randomised Controlled Trials
Christina Goldstein, ON; Brad Petrisor, ON; Brian Drew, ON; Mohit Bhandari, ON;

Purpose: A significant proportion of spine fusion operations may result in a non-union. Electromagnetic stimulation is a non-invasive method used to promote spine fusion although the efficacy of its use in this regard remains uncertain. The purpose of this systematic review and meta-analysis is to evaluate the effect of electromagnetic stimulation on spine fusion.

Method: Five electronic databases (MEDLINE, Embase, CINAHL, PubMed and the Cochrane Central Register of Controlled Trials) were searched from database inception to July 2009 for randomized controlled trials of electrical stimulation and spinal fusion. In addition, we performed a hand search of four relevant journals from January 2000 to July 2009, the on-line proceedings of the North American Spine Society Annual Meeting from 2002 to 2008 and bibliographies of eligible trials. Trials randomizing adult patients...
undergoing any type of spine fusion to active treatment with direct current, capacitance coupled or pulsed electromagnetic field stimulation or placebo and reporting on fusion rates were included. Two independent reviewers extracted data regarding clinical outcomes, stimulation device, treatment regimen and methodologic quality.

**Results:** Of 1650 studies identified seven met the inclusion criteria. Electromagnetic stimulation in lumbar spine fusion was evaluated in five studies and two addressed cervical spine fusions. The use of electromagnetic stimulation in lumbar spine fusion resulted in a significant decrease in the risk of non-union (relative risk 0.60, 95% confidence interval 0.38 to 0.93, p = 0.02, I² = 57%). The observed reduction in risk of nonunion with electromagnetic stimulation was not affected by smoking or the number of levels fused. Due to limited and conflicting trials, similar effects were not observed in the two studies evaluating cervical spine fusion rates (relative risk 0.85, 95% confidence interval 0.29 to 2.53, p = 0.77, I² = 56%).

**Conclusion:** Pooled analysis shows a 40% reduction in the risk of non-union of lumbar spine fusions with the use of electromagnetic stimulation although a similar effect was not observed for fusions of the cervical spine. However, due to study heterogeneity the current indications for the use of electrical stimulation in spine fusion remain somewhat unclear.