COA Paper Session 8: Reconstructive Upper Extremity 1 ●
Moderators George Athwal, ON, and Robert Litchfield, ON

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Association Between the Upward Migration Index and Functional and Quality of Life Outcomes in Arthroscopic Rotator Cuff Repair

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Purpose: The upward migration index (UMI) is a useful radiographic parameter for assessment of disorders of the rotator cuff. Utility of the UMI as a prognostic indicator for outcome following cuff repair has not been previously studied. The objective of this study was to determine if an association exists between the pre-operative UMI and the improvement in clinical and quality of life outcome scores following arthroscopic rotator cuff repair. **Method:** Patients with a full thickness tear of the rotator cuff who underwent an arthroscopic repair of the cuff were selected for review. Eighty-four patients were included in the series. Mean patient age was 55 (range 25-78). The UMI was measured by MRI, and patients were divided into three groups: < 1.25 (GROUP A), 1.25-1.35 (GROUP B) and > 1.35 (GROUP C). Outcome variables were the non-weighted Constant-Murley score, ASES and the WORC assessed at baseline, 6 month and 12 months post-operatively. The paired t-test was used to carry out comparisons in follow up and one-way ANOVA was used to carry out comparisons between groups. **Results:** There were 9 patients in group A, 33 in group B and 42 in group C. The improvement in scores from baseline to 1 year were as follows: ASES; 21.1 (A), 32.6 (B), and 38.4 (C); Constant 21.4 (A) 19.8 (B), and 24.2 (C) and WORC 31.9 (A), 42.7 (B), and 44 (C). Statistically significant improvements were observed in all groups in all outcome measures from baseline to 6 months and from 6 months to 1 year. Although the differences were not statistically significant ($p>0.05$), a trend toward greater improvement in outcomes was observed with higher upward migration indices. **Conclusion:** A lower UMI was associated with less improvement in functional and quality of life outcomes following arthroscopic rotator cuff repair, although these differences were not statistically significant. Patients with a low UMI demonstrated a significant improvement in functional and quality of life scores following surgery. In isolation, a low UMI should not represent a significant contraindication to treatment by arthroscopic rotator cuff repair.

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Does Physical Examination of the Shoulder Predict Patient-reported Functional Outcome in Patients with Previous Proximal Humerus Fractures?

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Purpose: To quantify how well the physical examination of the shoulder predicts patient-reported functional outcome in a cohort of patients with previous proximal humerus fractures. **Method:** Potential subjects were identified from a recent study cohort of proximal humerus fracture patients treated within the past six years. The cohort consisted of all fracture types and treatment modalities. Participants underwent a focused physical examination of their injured shoulder containing the components of the Constant-Murley shoulder score: range of motion for forward flexion, abduction, internal rotation, external rotation, and abduction strength measured by an IsoBex muscle strength analyzer. Participants also completed the following patient-reported functional outcome questionnaires: Disabilities of Arm, Shoulder, Hand (DASH), American Shoulder and Elbow Surgeons Standardized Shoulder Assessment Form (ASES), Simple Shoulder Test (SST), and Oxford Shoulder Score (OSS). Forward- and backward-stepwise linear regression was used to assess the relationship between the functional outcomes and the physical exam measurements. **Results:** Thirty-one subjects with a mean age of 70 ± 8 years participated. Sixteen patients were previously treated with ORIF and 15 were treated with sling immobilization. The mean physical examination measures were: flexion 117° ± 31°, abduction 117° ± 37°, internal rotation 7° ± 2°, external rotation 7° ± 4°, and strength 6 ± 5 Newtons. The mean functional outcome scores were: DASH 21 ± 19, ASES 82 ± 17, SST 8 ± 3, and Oxford 20 ± 8. Using linear regression, adjusted R-squared statistics suggest components of the physical exam can explain 38% of the Oxford, 50% of the DASH, 58% of the SST, and 70% of the ASES variance. Abduction strength was a significant predictor for all functional outcomes. Combinations of flexion, abduction, or internal rotation were also significant predictors depending on the outcome instrument being modeled. **Conclusion:** Physical exam of the shoulder accounts for differing amounts of patient-reported functional outcome variance. Abduction strength is the most consistent predictor of functional outcome within this cohort of proximal humerus fracture patients.

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Impact of Compensation Claims on Surgical Outcome in Patients with Rotator Cuff Related Pathologies

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Purpose: There is controversial information on recovery of patients with compensable injuries. The purpose of this matched case-control study was to examine the impact of an active compensation claim following a work-related shoulder injury on reporting disability as measured by subjective and objective outcomes at 1 year post-operatively. **Method:** Data of 506 consecutive patients who had undergone a decompression or rotator cuff repair were reviewed. One hundred and fourteen patients were on compensation related to their shoulder problems. Patients were matched with a historical control group (patients without a compensation claim) based on age (4 age groups: <40, 40-49, 50-59, 60-70), sex, and pathology (full-

thickness tear vs. no tear). Outcome measures used were a disease-specific outcome, the Western Ontario Rotator Cuff Index (WORC) and two shoulder specific instruments, the American Shoulder and Elbow Score (ASES) and the Constant Murley (CM) score. Paired and independent t-tests and an analysis of covariance were performed. **Results:** Data of the 214 patients (72 males and 35 females in each group) was used for analysis (mean age 48, SD: 10, range 20-69). Out of 107 patients in each group, 42 patients (58%) had undergone a full-thickness repair and 65 (61%) had surgeries related to impingement syndrome. Paired and independent t-tests showed that both groups improved significantly regardless of their claim status. However, the compensation group had a significantly lower level of improvement than the non-compensation group. An analysis of covariance which adjusted for pre-operative differences in disability scores showed that an active claim was indeed a strong predictor of follow up scores. **Conclusion:** This is the first study that has used a matched case-control design to control for potential confounding factors in injured worker population. Our results indicate that although patients with work-related injuries demonstrate a lower level of recovery, they still benefit from surgery.

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Contact Pressures and Glenohumeral Translations Following Subacromial Decompression: How Much is Enough?
Patrick Denard, OHSU; Timothy Bahney, OHSU; Robert M. Orfaly, OHSU

Purpose: Determine the ideal form of subacromial decompression. **Method:** Six cadaveric shoulders with intact rotator cuffs (RTC) underwent “smooth & move (SM),” limited acromioplasty with coracoacromial ligament (CAL) preservation, and CAL resection. Glenohumeral translation was measured in four directions utilizing electromagnetic spatial sensors. Peak RTC pressure was measured during arm abduction utilizing pressure film sensors. **Results:** Anterosuperior translation was unchanged after SM or acromioplasty, but increased from 2mm at baseline to 4mm following CAL resection with the arm at 300 abduction (p=0.03). There were no significant changes in other directions of translation following any procedure. In neutral humeral rotation RTC pressure was unchanged after SM (p=1.00). Pressure decreased 64% after a limited acromioplasty (p=0.04), and 72% after CAL resection (p=0.03). There was a trend towards increased abduction at which peak pressure occurred following CAL resection (760 compared to 620;p=0.11) In external rotation, RTC pressure decreased 26% following SM, 52% after limited acromioplasty, and 64% after CAL resection, but values were not statistically changed (p=0.52, p=0.08, and p=0.06). Similarly, abduction angle at which peak pressure was reached increased but was statistically insignificant after SM (720; p=0.75), limited acromioplasty (750; p=0.11), and CAL resection (790; p=0.08). In internal rotation, RTC pressure decreased 32% following the SM, 59% following the limited acromioplasty, and 58% following CAL resection, but none reached statistical significance (p=0.52, p=0.26, p=0.17). Abduction angle of peak pressure was unchanged after SM (670; p=0.63) and limited acromioplasty (670; p=0.63), but increased following CAL resection (620 vs. 790; p=0.04). **Conclusion:** A CAL resection

leads to increased anterosuperior instability. “Smooth and move” or acromioplasty can safely be performed without increasing translation. Rotator cuff pressure did not significantly decrease after SM. Rotator cuff pressure was significantly decreased to a similar degree following a limited acromioplasty or a CAL resection. A limited acromioplasty with preservation of the CAL may offer the greatest decrease in cuff pressures without the undesirable effect of increased translation. However, statistical significance was affected by high anatomic variability. Therefore, the choice between “smooth & move” and acromioplasty to decrease contact pressure is likely best to be individualized based on acromial morphology.

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The Effect of Posterior Capsular Tightness on Pressure in the Subacromial Space

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Purpose: Subacromial impingement syndrome is a painful condition which occurs during overhead activities as the rotator cuff is compressed between the greater tuberosity and the acromion. Unrecognized secondary causes of impingement syndrome may lead to treatment failure. Posterior capsular tightness, believed to alter shoulder joint kinematics, is often cited as a secondary cause but scientific evidence is lacking. The objective of this study was to evaluate the effect of posterior capsular tightness on pressure in the subacromial space. **Method:** Ten fresh-frozen cadaver shoulder specimens were mounted on a custom testing apparatus. With the scapula fixed, the deltoid and cuff muscles were loaded statically with a constant ratio to elevate the humerus in the scapular plane under physiologic loading conditions. For each treatment (intact capsule, 1cm and 2cm plication), pressure in the subacromial space and glenohumeral kinematics were recorded during elevation. The treatment order was randomly assigned to each specimen. Peak pressure and translation of the humeral head center were compared using a repeated measures ANOVA. **Results:** Peak subacromial pressures (mean±sd) were similar between treatment groups: 345±152 kPa, 410±213 kPa and 330±164 kPa for the intact, 1cm and 2cm plication respectively ($p>0.05$). No significant differences were found for superior or antero-posterior translations of the humeral head at the peak pressure position ($p>0.05$). **Conclusion:** Posterior capsular tightness, as a sole variable, did not contribute significantly to increased pressure in the subacromial space or to increased anterior or superior humeral head translation during abduction. Clinically, posterior capsular tightness may occur in association with impingement syndrome but may not play a significant role in causation.

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Contact Area, Contact Pressure and Load-failure of 3 Rotator Cuff Repair Method: A Biomechanical Analysis

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Purpose: Comparer la technique de réparation de la coiffe des rotateurs par haubanage tendineux en simple rangée aux techniques transosseuse et double-rangée par rapport à la surface et la pression de contact à l'interface tendon-os, et la force de rupture. **Method:** Pour tester la pression et la surface de contact, les techniques de réparation ont été faite sur 2 spécimens cadavériques (tête humérale et sus-épineux) chaque. Un film Prescale pressure-sensing a été interposé entre les tendons et l'os pendant 2 minutes avec une tension de 120N sur les tendons. Les films ont été numérisés pour l'analyse avec le logiciel ImageJ. La force de rupture a été testé sur un modèle Sawbones d'humérus proximal. Des tendons synthétiques en fibre de nylon et polyesther dans du silicone ont été créés pour les propriétés d'un tendon proportionnellement à la rigidité du Sawbones. La force a été appliquée à 135° jusqu'à rupture sur 2 montages par technique de réparation. La suture transosseuse utilisait 2 fils Orthocord dans 2 tunnels transosseux. La suture double rangé a été faite avec 2 ancres Spiralok médialement et 2 ancres Versalok latéralement avec des fils Orthocord. Le haubanage tendineux a été fait avec 2 ancres Panalok RC latéralement dans la zone corticale. **Results:** La surface de contact du haubanage de 17mm2 était significativement plus basse que de la suture transosseuse à 48mm2 (p=0.002) et double-rangée à 86mm2 (p=0.001). La différence entre transosseux et double rangée était significative (p=0.029). La pression de contact du haubanage de 0.353MPa était significativement plus basse que de la suture transosseuse à 0.441MPa (p=0.002) et double-rangée à 0.567MPa (p=0.003). La différence entre transosseux et double rangée était significative (p-0.029). La force de rupture du haubanage de 106N était significativement plus basse que de la suture transosseuse à 249N (p=0.03) et double-rangée à 316N (p=0.04). La différence entre transosseux et double rangée n'était pas significative. **Conclusion:** Le haubanage tendineux ne reproduit pas l'empreinte anatomique du sus-épineux sur la grande tubérosité ni une pression de contact adéquate en plus d'avoir une force de rupture plus faible. Malgré son coût plus élevé, la suture par double rangée est supérieure à la technique transosseuse ou simple rangée.

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Patient Reported Activities after Shoulder Replacement: Hemiarthroplasty versus Total Shoulder Arthroplasty

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Purpose: The indication to perform a total shoulder arthroplasty (TSA) versus a hemiarthroplasty is guided by a patient’s intended level of activity after surgery. It is unclear what activities patients actually perform following shoulder replacement, therefore, the purpose of this study was to compare

the self-reported activities of patients following either a TSA or hemiarthroplasty. **Method:** Two groups of 75 patients each, following TSA or hemiarthroplasty, were matched for a variety of demographic variables. A mailed activity questionnaire asked patients to report their level of pain, motion, strength, and a choice of 70 different activities. Reported activities were classified as high (i.e. tennis) or low (i.e. fishing) demand, and categorized as household (i.e. cooking), yard work (i.e. gardening), sporting (i.e. golf), or musical (i.e. piano). **Results:** Ninety-six (64%) patients completed the survey, 50 in the TSA group (27F:19M, avg. 53.2 yrs), and 46 in the HA group (29F:21M, avg. 53.5 yrs). Pain was not different between groups (3.6/10 TSA: 3.9/10 HA), yet a significant difference was reported in forward flexion (145° TSA: 120° HA, $P < .002$) and strength (6.3/10 TSA: 5.3/10 HA, $P < .01$). Across all categories whether it be high or low demand, the TSA group (10.4 activities / person) reported more activities compared with the hemiarthroplasty group (8.6 activities/person). **Conclusion:** The conventional understanding that a hemiarthroplasty provides the possibility for more activity following surgery is not supported by our data. Patients following a TSA reported better motion and strength and were more active than the hemiarthroplasty group.

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Cemented versus Uncemented Fixation of Humeral Components in Total Shoulder Arthroplasty for Osteoarthritis of the Shoulder

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Purpose: This prospective, randomized double-blinded clinical trial compared cemented fixation of the humeral component to uncemented/tissue-in-growth fixation in total shoulder arthroplasty for primary osteoarthritis of the shoulder. **Method:** All patients presenting with primary osteoarthritis of the shoulder requiring replacement were screened for eligibility. Patients were randomized in the operating room after glenoid preparation to the cemented or uncemented group by a computer-generated, stratified randomization procedure. Outcome measures included disease specific QOL assessment (WOOS), SF-12, ASES, MACTAR, radiographic evaluation of component fixation, operative time, complications and revision surgery. Patients were assessed by a blinded evaluator in post-operative intervals of 2 and 6 weeks, and 3, 6, 12, 18, and 24 months. The primary endpoint was the WOOS score at 2 years. **Results:** One hundred and sixty-one patients were consented and randomized for the study. There were 80 patients in the cemented and 81 patients in the uncemented group. At baseline, the groups were alike with regards to demographics and baseline evaluations. The WOOS scores at post-operative intervals of 12, 18 and 24 months showed a significant difference ($p=0.009$, 0.001, 0.028 respectively) in favour of the cemented group. The cemented group also had better

strength (3 m p=0.038, 12 m p= 0.036, 18 m p=0.051, 24 m p=0.053) and forward flexion (6m p=0.031, 12 m p=0.04). As expected, the operative time was significantly less for the uncemented group (C = 2.26h +/- .63; U = 1.69h +/- 1.9, p= 0.03). **Conclusion:** These findings provide the first evidence that cemented fixation of the humeral head provides better quality of life, strength and ROM than uncemented fixation. This was a Tier 1 Project of the JOINTs Canada group.

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Bony Increased-offset Reverse Shoulder Arthroplasty (BIO RSA): A Biologlic Solution to Scapular Notching, Prosthetic Instability and Limited Shoulder Rotation

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Purpose: We hypothesized that lateralization of the RSA, with a glenoid bone graft taken from the osteotomised humeral head, would prevent those problems without increasing torque on the glenoid component by keeping the center of rotation within the glenoid. The objectives of this study were to describe the results of the first 12 patients that underwent a bony increased-offset RSA (BIO RSA). **Method:** Thirty-six shoulders in 34 consecutive patients with cuff tear arthritis (mean age 72 years, range 52-86 years) received a BIO RSA, consisted of a RSA incorporating an autogenous humeral head bone graft placed beneath the glenoid baseplate. A baseplate with a lengthened central peg (+25 mm) was inserted in the glenoid vault, securing the bone graft beneath the baseplate and screws. All patients underwent clinical and radiographic (computed tomography) review at a minimum 1-year follow-up. **Results:** All patients were satisfied or very satisfied and all had no or slight pain. Mean active elevation increased from 72° to 142° ($p<0.05$), external rotation from 10° to 18° ($p<0.05$) and internal rotation from L4 to L3 ($p>0.05$). Constant Score improved from 27 to 63 points ($p<0.05$). The Subjective Shoulder Value (SSV) increased from 27% to 73% ($p<0.05$). Radiographically, the graft healed to the native glenoid in all cases and no graft resorption under the baseplate was observed. Complications included one patient with scapular notching (stage 1) and one patient with previous radiotherapy had a deep infection. No postoperative instability, and no glenoid loosening were observed. **Conclusion:** The use of an autologous bone graft harvested from the humeral head can lateralize the center of rotation of a RSA while keeping the center of rotation at the glenoid bone-prosthesis interface. The clinical advantages of a BIO RSA are a decrease in scapular notching, enhanced stability and mobility, and improved shoulder contour while keeping the center of rotation at the glenoid bone-prosthesis interface. This bony lateralization allows maintenance of the principles of Grammont and seems to be more appropriate than prosthetic lateralization. These promising early results of this novel procedure warrant further investigation.

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Propionibacterium Acnes Infections in Revision Shoulder Surgery: An Analysis of 20 Consecutive Cases with Positive Intra-operative Cultures

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Purpose: The objectives of this study were to correlate the clinical course of all patients with positive intra-operative P. acnes cultures in revision shoulder surgery with the cultures and intraoperative findings to determine the clinical significance of the positive cultures. **Method:** From 2005 to 2007 all revision shoulder surgeries were managed with a standard protocol in which (a) antibiotics were withheld until cultures obtained, (b) at least four fluid and tissue cultures were submitted, (c) frozen sections were obtained of any tissue grossly suspicious for infection, and (d) the surgeons' pre-, intra-, and post-operative suspicion for infection were recorded. Samples were observed for growth for 28 days. All cases were reviewed at a mean follow-up of 4.2 months (range, 1-12). Comparisons were made between infection cases and "clinically Insignificant" cases, with respect to: (1) risk factors, (3) symptoms/signs of infection, (2) active range-of-motion, (2) Simple Shoulder Test (SST) scores, values of (3) WBC, (4) ESR and (5) CRP, number of positive cultures for (6) P acnes and (7) other organisms and (8) subjective pre-operative, intra-operative and post-operative suspicion for occult infection. **Results:** P. acnes was cultivated from 20 cases in 19 patients. Five cases (25%) were considered significant infections, while fifteen cases were considered "clinically insignificant". The mean number of cultures positive for P. acnes was 1.7 (range, 1-4) per case. The mean active forward flexion ($p=0.03$) and internal rotation ($p=0.03$) was less for infection cases than for clinically Insignificant cases. Pre-operative ESR ($p=0.04$) and CRP ($p=0.02$) values were higher for infection cases. Infection cases had a higher number of positive intra-operative cultures for other organisms ($p=0.04$). **Conclusion:** No combination of clinical parameters would reliably predict clinical infection in patients with positive intra-operative P. acnes cultures in revision shoulder surgery. In particular, positive P. acnes intra-operative cultures do not always represent true clinical infections. Pre-operative loss of range-of-motion, elevated ESR and CRP and positive intra-operative cultures for other organisms appear to correlate with true infections. The determination of a clinically significant infection needs to be based on the entirety of the clinical and laboratory information for each shoulder case.