10.5° in the +rcRSA cohort (p = 0.011) but was similar to the TSA cohort of 14.7° (p = 0.244). There was a similar preoperative mean glenoid inclination angle between groups. At final follow up there were no differences in VAS or ASES between -rcRSA vs +rcRSA and -rcRSA vs TSA. SSV was lower in +rcRSA (83.9°) compared to -rcRSA (91.8°, p = 0.021), but was similar to TSA (90.5°, p = 0.073). Similar ROM was achieved in forward flexion, external rotation, and internal rotation at final follow up between +rcRSA and -rcRSA. Similar forward flexion was achieved between +rcRSA and TSA, though TSA demonstrated greater external rotation (44° vs 38°, p = 0.041) and internal rotation (6.5° vs 5.0°, p = 0.001) compared to +rcRSA at final follow-up. There were no differences in complications between +rcRSA and either RSA or TSA cohorts. DISCUSSION Preservation of the rotator cuff in RSA demonstrated similar outcomes at a minimum of 12 months compared to RSA with a deficient rotator cuff and TSA with the exception of slightly greater ER and IR with TSA. While indications have expanded for RSA beyond rotator cuff arthropathy, our study demonstrates that RSA with preservation of the rotator cuff demonstrates excellent outcomes without increased risk of complications.

Category: Shoulder - Arthroplasty

### Glenoid Tilt Affects Kinematics During Internal Rotation That Are Associated With Clinical Outcomes After Reverse Shoulder Arthroplasty

**Abstract ID# 22513**

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**Summary:** Inferior glenoid tilt may negatively influence kinematics that lead to poorer outcomes in the hand-to-back motion after reverse shoulder arthroplasty.

**Data:**

**INTRODUCTION:** Internal rotation is not reliably improved after reverse shoulder arthroplasty (RSA). Surgical parameters such as glenosphere size, lateralization, and retroversion have been associated with internal rotation after RSA. The aim of this study was to determine effects of surgical technique and prosthesis geometry on in vivo movement patterns and patient-reported outcomes (PROs) after RSA. We hypothesized that kinematics and contact path that are influenced by greater glenosphere size, glenoid tilt, and lateralization during the hand-to-back motion would correlate with better PROs.

**METHODS:** Patients who received RSA within previous 1-5 years consented to participate in this IRB-approved study. RSA was performed using standard 135-degree or 145-degree humeral implants. Lateralization, glenosphere size, and eccentricity were recorded from surgical notes. Humeral retroversion and glenoid tilt were measured on post-operative CT. Participants performed a hand-to-back motion while synchronized biplane radiographs were collected at 50 images/s for 2 seconds. Digitally reconstructed radiographs from subject-specific segmented bone tissue of the humerus and scapula with respective implants were matched to biplane radiographs with sub-millimeter accuracy to determine six degree-of-freedom scapular and humeral kinematics. The contribution of each component of rotation (glenohumeral (GH) abduction, plane of elevation and internal/external (I/E) rotation, as well as scapular upward rotation, protraction, and tilting) to the overall motion was calculated. Average end position, peak angles, and range of motion (ROM) of all rotations were found. ASES, DASH, and CMS scores were collected at testing. Implant characteristics and surgical techniques that predicted kinematics were identified using multiple linear regression using forward selection with SPSS 29.0 software. The center of contact between a 3D CAD model of the polyethylene and glenosphere was calculated and superior/inferior (SI) and anterior/posterior (AP) locations were averaged across corresponding angles to establish contact path. Associations between the most anterior, posterior, inferior, and superior points on the contact path and surgical technique were identified using multiple linear regression using forward selection. Pearson correlation evaluated associations between either kinematics or contact path and PROs. Significance was set at p < 0.05. RESULTS: The study included 35 patients who received RSA (17M, 18F; 72.8 ± 7.3 years) with average follow-up of 2.2 ± 1.1 years. Inferior glenoid tilt correlated with less GH abduction, more scapular upward rotation, and less scapular protraction (all p < 0.05). 145° neckshaft implants and higher retroversion angles both associated with more anterior contact paths, and larger glenosphere had a more inferior contact path (all p < 0.05).

DASH and ASES scores improved with more scapular protraction (p = 0.026 and p = 0.014, respectively). DISCUSSION: During hand-to-hand after RSA, increased scapular protraction was the primary kinematic factor associated with better PROs. The only surgical factor associated with scapular protraction was glenoid tilt. This suggests that more inferior glenoid tilt decreases scapular protraction, leading to less favorable PROs. Contrary to previous work, we found lateralization, a surgical parameter that has been associated with improved IR ROM, did not correlate with kinematics or contact path location. The mechanism for lateralization’s influence on IR performance may not be explained by in vivo kinematics.

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### Comparison of Clinical Outcomes Using Inlay Versus Onlay Humeral Trays in Reverse Shoulder Arthroplasty for Patients with Cuff Tear Arthropathy

**Abstract ID# 22831**

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**Summary:** This study found that at a two-year minimum follow up, the position of humeral tray as either inlay or onlay did not influence the clinical outcomes of function, range of motion, complications including baseplate loosening and acromial stress fracture, and scapula notching.

**Data:** Introduction The inlay design of humeral tray in reverse shoulder arthroplasty (RSA) has been suggested to have the advantage of better humeral side fixation, but there are concerns of greater tuberculosis fracture. In comparison, onlay humeral tray in RSA are suggested to have the advantages of impingement free range of motion and reduced scapular notching, but there are concerns of increased scapula stress fractures. The aim of this study was to compare the clinical results among patients with CTA undergoing RSA with two prostheses having lateralized glenosphere and 135° NSA, but which differed in the position of the humeral tray as either inlay or onlay design. Methods This was a retrospective study of prospectively obtained data from a single institutional database of shoulder division of a tertiary care center and was approved by our institutional review board. The database was searched for all patients who underwent RSA between 2009 to 2017 (N = 511). To be included, patients with a diagnosis of and cuff tear arthropathy had to be treated with a RSA prostheses having a lateralized glenosphere and 135° NSA either with an inlay or onlay humeral tray design. 102 patients met the inclusion criteria and had a minimum of 2 years follow up (mean, 44, range 24-125 months). Of the included 102, 63 (62%) had implanted a RSA design with an inlay humeral tray (inlay group) and 39 (38%) had onlay tray (onlay group). All patients underwent a preoperative and postoperative evaluation including a physical examination for range of motion (ROM), radiographs, and multiple PROs (ASES, SST, and WOOS score). The clinical significance was evaluated using published minimal clinically important difference (MCID) values. Results Preoperatively there were no significant differences in the two groups demographically except for more proportion of females in the inlay group (75% vs 56%, P = 0.04). The preoperative PROs and ROM were not statistically different between the inlay and onlay groups. The comparison of final follow up PROs and ROM including external rotation were not statistically or clinically significantly different between inlay or onlay groups. There was no statistically significant difference between the inlay and onlay design for baseplate loosening (3% vs 5%, P = 0.63) and revision (0% vs 5%, P = 0.07). Of 3 patients in the onlay group who required a revision, the reason was baseplate failure in one patient, instability in another patient, and periprosthetic shoulder infection in the third patient. The rate of acromial stress fracture (3% vs 5%, P = 0.63) and prosthesis dislocation (0 vs 2.5%, P = 0.20) were also similar between inlay and onlay groups (Table 3). There was no difference between the onlay and inlay groups postoperatively for the rate
scapula notching neither by incidence (21% vs 8%, P=0.08) nor by distribution. Conclusion: This study found that at a two-year minimum follow up, the position of humeral tray as either inlay or onlay did not influence the clinical outcomes of function, range of motion, complications including baseplate loosening and acromial stress fracture, and scapula notching.

Category: Shoulder - Arthroplasty

Periarticular Injection In Addition To Interscalene Nerve Block Can Decrease Opioid Consumption And Pain Following Total Shoulder Arthroplasty: A Prospective Comparison Cohort Study

Abstract ID#: 21744
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Summary:
The addition of an intra-operative peri-articular cocktail injection appears to be a safe and effective method to reduce acute post-operative pain following TSA compared to an isolated interscalene nerve block.

Data:
INTRODUCTION: Interscalene nerve block (INB) is as an effective technique to provide post-operative anesthesia for total shoulder arthroplasty (TSA). However, the analgesic effects of the block typically resolve between 8-and 24-hours following administration, which results in rebound pain and subsequent increased opioid utilization. With the aim of transitioning the shoulder arthroplasty procedure toward out-patient surgery, decreasing opioid consumption in the acute post-operative period is the main goal to achieve a shorter hospital stay. The objective of this study was to determine the effect that the combination of INB and intra-operative peri-articular injection (PAI) has on opioid consumption and acute post-operative pain scores in patients undergoing TSA. We hypothesized that the combination of INB + PAI will significantly reduce opioid consumption and pain scores for the first 24 hours following surgery as compared to INB alone.

METHODS: We reviewed 130 consecutive patients who underwent elective primary TSA at a single tertiary institution. The first 65 patients were treated with INB alone, followed by 65 patients treated with INB + PAI. The PAI utilized was 50ml of a combination of Ropivacaine (123mg), Epinephrine (0.25mg), Clonidine (40mcg), and Ketorolac (15mg). The PAI was injected using a standardized protocol; 10ml into the subcutaneous tissues prior to incision, 15ml into the supraspinatus fossa, 15ml at the base of the coracoid process, and 10ml into the deltoid and pectoralis muscles. A standardized post-operative oral pain medication protocol was utilized for all patients. The primary outcome measured was acute post-operative opioid consumption represented by morphine equivalent units (MEU), while the secondary outcome measured was Visual Analog Scale (VAS) pain scores over the first 24 hours after surgery, operative time, length of stay, and acute peri-operative complications.

RESULTS: There were no significant differences in patient demographics between the INB alone compared to patients with INB + PAI. Patients who received INB + PAI had a significantly lower 24-hour post-operative opioid consumption as compared to INB alone group (38.6±30.5 MEU versus 60.5±37.3 MEU, P<0.001). Moreover, the demand for rescue intravenous opioids from severe breakthrough pain was also decreased by 16.9% in INB + PAI group (20% versus 36.9%, P=0.033). Additionally,VAS pain scores for the first 24 hours following surgery in the INB + PAI group was significantly lower as compared to INB alone group (2.9±1.5 versus 4.3±1.6, P<0.001). There were no differences between both groups in the operative time, length of inpatient stay and acute peri-operative complications.

CONCLUSION: Patients undergoing TSA with INB + PAI demonstrated significantly decreased 24-hour post-operative total opioid consumption and 24-hour post-operative pain scores as compared to group treated with INB alone. There was no observed increase in acute peri-operative complications related to PAI. Thus, the addition of an intra-operative peri-articular cocktail injection appears to be a safe and effective method to reduce acute post-operative pain following TSA compared to an isolated interscalene nerve block. LEVEL OF EVIDENCE: Level II, Prospective Cohort Design; Treatment Study

KEYWORDS: Total shoulder arthroplasty, Interscalene nerve block, Peri-articular injection, Multimodal analgesia, Peri-operative analgesia, Opioid consumption

Category: Shoulder - Arthroplasty

Surgical Parameters are Associated With Kinematics, Contact Path, and Clinical Outcomes After Reverse Shoulder Arthroplasty: During Hand to Head Motion

Abstract ID#: 22512
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Summary:
Reverse retroversion, neckshaft angles and eccentricity are associated with kinematics, contact path, and clinical outcomes after reverse shoulder arthroplasty during hand to head motion.

Data:
INTRODUCTION: External rotation (ER) is a post-surgical assessment after reverse shoulder arthroplasty (RSA) because it is essential to activities of daily living, such as the hand-to-head motion. The aim of this study was to determine the effects of surgical technique and prosthesis geometry on in vivo kinematics, contact path, and patient-reported outcomes (PROs) during the hand-to-head motion after RSA. We hypothesized that greater lateralization, greater retroversion, and lower humeral neck-shaft angles would associate with kinematics and contact paths during hand-to-head that are associated with improved PROs. METHODS: Patients who received RSA within the previous 1-5 years consented to participate in this IRB-approved study. RSA was performed using standard 135-degree or 145-degree humeral implants. Lateralization, glenosphere size, and eccentricity were recorded from surgical notes. Humeral retroversion and glenoid tilt were measured on post-operative CT. Participants performed 3 trials of hand-to-head motions while synchronized biaxial radiographs were collected at 50 images/s for 2 seconds. Digitally reconstructed radiographs from subject-specific segmented bone tissue of humerus and scapula with respective implants were matched to biaxial radiographs with sub-millimeter accuracy to determine six degree-of-freedom kinematics. The contribution of each glenohumeral (GH) and scapular rotation (GH abduction, plane of elevation and internal/external (I/E) rotation, as well as scapular upward rotation, protraction, and tilt) to overall shoulder motion was calculated. Average end position of all 6 rotations was found. The path of the center of contact between a 3D CAD model of the polyethylene and the glenosphere was calculated. ASES, DASH, and CMS scores were collected at testing. Implant characteristics and surgical techniques that predicted kinematics (peak angles, ROM, contribution, end position) and contact path location were identified using multiple linear regression using forward selection with SPSS 29.0 software. Associations between kinematics and PROs were evaluated with Pearson correlations. Significance was set at p<0.05.

RESULTS: This study includes 35 RSA patients (17M,18F,72.8±7.3 years) with average follow-up of 2.2±1.1 years. Greater retroversion angles correlated with less peak abduction and scapular protraction contribution (p=0.038 & p=0.005, respectively). Greater eccentricity was associated with more scapular upward rotation contribution (p=0.005). 145° neckshaft angles displayed more anterior contact path (p=0.006). CMS scores improved with more abduction (all p<0.05). ASES and DASH scores improved with more scapular upward rotation (all p<0.05). DASH and CMS scores improved with more superior contact paths (all p<0.05). DISCUSSION: During hand-to-head, favorable PROs are associated with more glenohumeral abduction and higher upward scapular rotation. Those kinematic outcomes are associated with the surgical techniques of less retroversion, greater eccentricity, and more Superior contact path. Contrary to our hypothesis, greater retroversion was not associated with kinematics that were associated with better PROs, and lateralization and neck-shaft angle did not have significant effect on this motion. Additional study is needed to identify the point at which less retroversion and more eccentricity begin to worsen outcomes. Control subject kinematics data are needed to evaluate RSA’s restoration of healthy kinematics. Satisfaction and function may improve by identifying techniques that affect kinematics associated with better outcomes after RSA. Study was funded by NIH Grant: R03AG064417

Summary: The addition of an intra-operative peri-articular cocktail injection appears to be a safe and effective method to reduce acute post-operative pain following TSA compared to an isolated interscalene nerve block.