Machine Learning Can Predict Anterior Elevation After Reverse Total Shoulder Arthroplasty

Abstract ID# 23295
All Authors:
Eduardo Franceschetti MD ITALY
Pietro Gregori MD ITALY
Simone De Giorgi Ing ITALY
Tommaso Martire Ing ITALY
Giancarlo Giurazza MD ITALY
Giagio Zampognia MD ITALY
Rocco Papalia MD, PhD, Prof. ITALY

Summary:
Our machine learning study demonstrates that Machine learning could provide high predictive algorithms for anterior elevation after reverse shoulder arthroplasty. The differential analysis between the utilized techniques showed higher accuracy in score prediction for the Support Vector Regression.

Data:
Background: One of the most frequent concerns of the increasing number of patients undergoing shoulder reverse arthroplasty is the possibility to regain an acceptable and not painful range of motion after surgery. The aim of the present study was to individuate and compare specific Machine Learning algorithms that could predict post operative anterior elevation score after Reverse shoulder arthroplasty surgery at different time points.

Methods: Data from 105 patients who underwent reverse shoulder arthroplasty at the same institute have been collected with the purpose of generating algorithms which could predict the target. 28 features were selected and applied to two different Machine Learning techniques: Linear Regression and Support Vector Regression (SVR). These two techniques were also compared in order to define the most faithfully predictive.

Results: Using the extracted features, the SVR algorithm resulted in a mean absolute error (MAE) of 11.6 and a classification accuracy (PCC) of 0.88 on the test-set. Linear Regression, instead, resulted in a MAE of 13.0 and a PCC of 0.85 on the test-set.

Conclusions: Our machine learning study demonstrates that Machine learning could provide high predictive algorithms for anterior elevation after reverse shoulder arthroplasty. The differential analysis between the utilized techniques showed higher accuracy in score prediction for the Support Vector Regression.

Category: Shoulder - Arthroplasty

Outcomes of Total Shoulder Arthroplasty in Patients with Prior Anterior Shoulder Instability: Minimum 5-year Follow-up

Abstract ID# 22960
All Authors:
Matthew L Vopat MD UNITED STATES
Jared A Hanson BA UNITED STATES
Bradley Fossum BA UNITED STATES
Annalise Peebles BA UNITED STATES
Marilee P. Horan MPH UNITED STATES
Rony-Orjité Dey Hazra MD, Dr.med. UNITED STATES
Toufic R. Jilideh MD UNITED STATES
Matthew T. Provencher MD UNITED STATES
Peter J. Millett MD, MSc UNITED STATES

Summary:
This study evaluated clinical outcomes of patients that underwent total shoulder arthroplasty with a history of operatively and nonoperatively managed anterior shoulder instability.

Data:
Background: Patients with a history of anterior shoulder instability (ASI) commonly progress to glenohumeral arthritis or even “dislocation arthropathy” and often require total shoulder arthroplasty (TSA). The purposes of this study were to 1) report patient reported outcomes (PROs) after TSA in patients with a history of ASI, 2) compare TSA outcomes of those whose ASI was managed operatively versus those managed nonoperatively, and 3) report PROs of TSA in patients who previously underwent arthroscopic versus open ASI management.

Methods: Patients were included if they had a history of ASI and were at least 5 years out from TSA performed by a single surgeon between 10/2005 and 01/2017. Exclusion criteria included prior rotator cuff repair, hemi-arthroplasty, or glenohumeral joint infection prior to index TSA. Patients were separated into two groups, those with previous operatively managed ASI and those whose ASI was treated nonoperatively. Prospectively collected demographic, surgical, and subjective data were retrospectively reviewed. PROs utilized were the ASES score, SANE, QuickDASH, SF-12 PCS. Failure was defined as revision TSA surgery, conversion to reverse TSA, or prothetic joint infection. Kaplan-Meier survivorship analysis was performed. Results: 36 patients (27 male, 9 female) with a mean age of 56.4 years (range, 18.8-72.2) were included. Patients in the operative ASI group were younger than those in the nonoperative ASI group (50.6 vs 64.0 years, p<.001). Operative ASI patients underwent 10 open and 11 arthroscopic anterior stabilization surgeries prior to their TSA (mean, 2; range, 1-4). 6 of 21 (28.6%) TSA failures in patients with operative ASI while there were no failures in the nonoperative ASI group (p=0.03). Follow-up was obtained in 28 of 30 (93%) eligible patients at an average of 7.45 years (range, 5.0-13.6). In the collective cohort, ASES, SANE, QuickDASH, and SF-12 PCS scores significantly improved with no differences in the postoperative PROs between the two groups.

Conclusions: TSA survivorship is decreased in patients with a history of ASI surgery compared to those without prior surgery. In those who survive, there is no significant difference in PROs.

Category: Shoulder - Arthroplasty

Reverse Shoulder Arthroplasty With a Preserved Rotator Cuff: A Comparison Of Outcomes After Reverse Shoulder Arthroplasty With a Deficient Rotator Cuff and Anatomic Total Shoulder Arthroplasty

Abstract ID# 22994
All Authors:
Ehab M Nazzal MD UNITED STATES
Justin James Greiner MD UNITED STATES
Rajiv Pabbati Reddy BS UNITED STATES
Ajinika Rai BS UNITED STATES
Matthew Como BS UNITED STATES
Michael Andrew Fox MD UNITED STATES
Zachary J Herman MD UNITED STATES
Albert Lin MD UNITED STATES

Summary:
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.

Data:
INTRODUCTION Reverse total shoulder arthroplasty (RSA) has traditionally been utilized with success in the setting of rotator cuff arthropathy. Indications for RSA have expanded beyond the traditional paradigm to include individuals with intact rotator cuffs including elderly patients and those with abnormal glenoid morphology. The purpose of this study was to compare outcomes of RSA with an intact rotator cuff to RSA for cuff arthropathy and anatomic total shoulder arthroplasty (TSA).

RESULTS AND METHODS Patients at a single institution that underwent RSA and TSA between 2015 and 2020 were identified. RSA that was performed with an intact rotator cuff (+rcRSA) was compared to RSA performed without an intact rotator cuff (+rcRSA) and an anatomic TSA cohort (TSA). Patients were included with a minimum of 12 month follow up. Baseline demographics were obtained and glenoid version and inclination were calculated. Preoperative and postoperative range of motion and patient reported outcomes including visual analogue scale (VAS), subjective shoulder value (SSV), and American Shoulder and Elbow Surgeries (ASES) scores were obtained. Postoperative complications were recorded. Paired t-tests and Chi-squared and Fisher’s exact test were utilized for continuous and binary variables, respectively.

Statistical significance was set at p < 0.05. RESULTS There were 24 patients in +rcRSA, 69 in RSA, and 93 in TSA cohorts. There were more women in +rcRSA (75.8%) than +rcRSA (37.7%, p=0.001) and TSA (37.6%, p=0.001). Average age was similar between +rcRSA (71.1) and +rcRSA (72.4, p=0.237) cohorts while the TSA cohort was younger (66.0, p=0.21). Preoperative mean glenoid retroversion was significantly higher in the +rcRSA cohort at 18.2° compared to 15.4°.
Abstracts

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 arthroplasty, 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
All Authors:
Ajinkya Rai BS UNITED STATES

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 movement 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 (E/I) rotation, as well as scapular upward rotation, protraction, and tilt) 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-back 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.

ACKNOWLEDGEMENTS: Work was funded by NIH Grant: R03AG064417

Category: Shoulder - Arthroplasty

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

Abstract ID# 22831
All Authors:
Prashant Meshram MBBS, MS, DNB (Ortho) UNITED STATES
Punyawat Apiwatanakul MD THAILAND
Stephen C. Weber MD UNITED STATES
Uma Srilakshmanan MD, MBA, MPH UNITED STATES
Edward G. McFarland UNITED STATES

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 tuberosity 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 primary 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 peri-prosthetic 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 x