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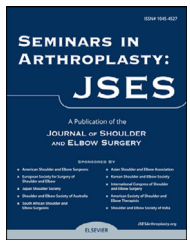

Effect of primary diagnosis on return to sport after reverse total shoulder arthroplasty

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ABSTRACT

Background: Increasing evidence exists regarding the impact of primary diagnosis on clinical outcomes following reverse total shoulder arthroplasty (RTSA). Expanding indications coupled with emerging clinical evidence has resulted in increased use of RTSA for glenohumeral osteoarthritis (GHOA) with an intact rotator cuff. The ability to return to sports after RTSA is a common concern for patients; however, most literature evaluating this does not stratify patients by diagnosis. The purpose of this investigation was to evaluate the effect of diagnosis on return to sports after RTSA.

Methods: A single institution, retrospective study was performed on patients who underwent primary RTSA with a minimum 2-year follow-up. Patients answered a 7-question survey regarding sport participation within 3 years before surgery and the level to which they returned to their sports after surgery. Patient demographics, patient-reported outcome scores, and range of motion were accessed from the database. Descriptive statistics and univariate analysis were performed to assess differences between patients who did not return to sport or did so at lower level and those that returned at the same or higher level, as well as between patients with GHOA and those with rotator cuff disease. Binary logistic regression was performed to assess predictors of returning to sports.

Results: A total of 106 patients meeting inclusion criteria were identified with a mean age of 72 years (range, 55-88 years). Ninety-six patients (90.6%) returned to playing sports, of which 84 (87.5%) returned at the same or higher level. Patients with GHOA demonstrated a higher rate of return to sport compared to those with rotator cuff disease (95.6% vs. 81.6%; $P = .033$). Logistic regression controlling for sport intensity demonstrated that GHOA is a predictor of returning to sports (odds ratio = 6.3; $P = .017$). Patients who did not return to sports or did so at a lower level had higher preoperative pain ($P = .007$), lower postoperative SANE (Single Assessment Numerical Evaluation of the Shoulder) ($P = .027$), lower preoperative and postoperative ASES (American Shoulder and Elbow Surgeons) scores

Approval for this study was received from the New England Baptist Hospital Institutional Review Board (Protocol #1825412).

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($P = .004$ and $P = .016$, respectively), less preoperative and postoperative forward elevation ($P = .037$ and $P = .019$, respectively), lower postoperative external rotation ($P = .004$), and lower preoperative internal rotation ($P = .027$).

Conclusion: The ability of patients to return to sports after RTSA is highly influenced by preoperative diagnosis. Patients with GHOA have higher rates of return to sport than previously recognized. These results are useful for establishing expectations with patients regarding their postoperative activity level.

Level of evidence: Level IV; Retrospective Cohort Study

The rate of shoulder arthroplasty procedures, including hemiarthroplasty, anatomic total shoulder arthroplasty (TSA), and reverse shoulder arthroplasty (RTSA), has exponentially increased in the United States over the past 2 decades. Lui et al[10] found that there were approximately 70,000 combined shoulder arthroplasty procedures done in 2011 compared to just 14,000 in 2000. More recently, Best et al[2] found that the rates of both RTSA and TSA have substantially increased from 2012 to 2017 with a more significant increase in RTSA from 22,835 in 2012 to 62,705 in 2017 vs. TSA from 29,685 in 2012 to 40,665 in 2017.

Surgical indications for RTSA have broadened in recent years to include massive rotator cuff tear (MRCT), rotator cuff tear arthropathy (CTA), complex proximal humerus fractures, proximal humerus fracture nonunions, revision shoulder arthroplasty, inflammatory arthropathy, and primary glenohumeral osteoarthritis (GHOA).[11,18] The expanded indications for RTSA have correlated with an increased utilization of the procedure, and therefore, patients undergoing RTSA have a wider range of demographic characteristics and functional goals.[9] As a result, more patients undergoing RTSA are eager to return to sports and physical activity postoperatively. While pain and limited functional use of the shoulder are the most commonly cited reasons for patients undergoing RTSA, several studies have found that the desire to continue sports is an increasingly common expectation for patients undergoing shoulder arthroplasty.[4,7,10,12,15,18] Therefore, understanding factors that impact the likelihood of returning to sports after RTSA is important so that patients can be appropriately counseled preoperatively to have realistic expectations.

Several recent studies evaluating return to sport after RTSA have reported variable ability to return to preoperative sports participation and level of sports competitiveness.[1,3,4,9,13] However, these studies have not distinguished potential differences in ability to return to sports based on primary preoperative diagnosis. Understanding preoperative factors that may influence a patient's likelihood or ability to return to sport are important for patient education and counseling. Therefore, we sought to determine if preoperative diagnosis influences returning to sports after RTSA. We hypothesized that patients with a primary diagnosis of GHOA would have a higher return to sport than those diagnosed with CTA/MRCT following RTSA.

Materials and methods

Patient selection

A retrospective study using patient data from a prospectively maintained institutional database with >75% overall follow-up (Oberd, Columbia, MO, USA) was performed following approval from the institutional review board (#1825412). Patients were identified who underwent elective primary reverse shoulder arthroplasty between September 2015 and October 2019 for the treatment of GHOA, rotator CTA, or MRCT without arthritis. All procedures were performed by a single high-volume, fellowship-trained shoulder surgeon at a large private institution. The patients in this study were indicated for RTSA as opposed to other surgical treatments, including TSA, for various reasons, including joint pathology, demographics, past medical and surgical history, patient-specific risk portfolio for complications, and surgeon and patient preference.

Patients identified were included in this study if they met the above criteria in addition to having a minimum follow-up of 2 years and complete preoperative and postoperative patient-reported outcome measures (PROMs). Patients were excluded if they: (1) had incomplete preoperative or postoperative PROMs or range of motion (ROM) testing, (2) underwent RTSA for fracture, chronic dislocation, avascular necrosis, or any other indication aside from those listed previously, or (3) underwent revision shoulder arthroplasty.

Surgical technique

All patients received a preoperative interscalene nerve block and underwent general anesthesia. A deltopectoral approach was utilized in all cases. If intact, the biceps tendon was tenodesed to the pectoralis major tendon. A subscapularis peel was performed, which was repaired to the lesser tuberosity at the conclusion of each procedure if possible. In all cases, the supraspinatus, infraspinatus, and teres minor tendons were not operated on, regardless of state. No patients required glenoid bone grafting or an augmented baseplate. Following baseplate fixation and glenosphere selection, attention was turned back to the humerus. A standard-length humeral stem with a standard or ≥4 mm polyethylene insert was used in all patients. DJO Altivate Reverse (DJO Surgical, Lewisville, TX,

Table I – Over-the-phone patient questionnaire to assess patients' level of sport participation before and after reverse total shoulder arthroplasty.

Question	Answer options
Q1. Did you participate in any sports within three years prior to surgery?	Yes
	No
Q2. If yes, what type of sports did you do within three years prior to surgery?	Low demand*
	Moderate demand†
	High demand§
Q3. Of the selected sports, which would you consider your top/favorite sport?	Low demand*
	Moderate demand†
	High demand§
Q4. After surgery, were you able to get back to playing sports?	Yes
	No
Q5. If yes, at which level compared to before surgery?	Lower level
	Same level
	Higher level
Q6. If you did not resume sports after surgery, why did you stop playing?	Surgeon recommendation
	Because of the surgery/unable to participate
	Pain when playing
	No interest in restarting them
	Other
Q7. Overall, how satisfied are you with the surgery?	Dissatisfied
	Somewhat satisfied
	Satisfied
	Very satisfied

* Low-demand sports: golf, bowling, rowing, cycling, swimming, cross country skiing, running, and gym.
† Moderate-demand sports: doubles tennis, weightlifting, softball, squash, pickleball, and downhill skiing.
§ High-demand sports: basketball, martial arts, and singles tennis.

USA) components were used in all patients, with varied sizing based on patient anatomy. All patients followed a physician-guided home therapy protocol, which included restricted ROM for the first 2 postoperative weeks followed by a gradual progression of exercises to regain ROM and strength.

Clinical outcome assessment

Clinical evaluation included the assessment of active ROM) and PROMs. Forward elevation (FE), external rotation (ER) at 0° of abduction, and internal rotation (IR) were assessed preoperatively and at a minimum of 2 years after surgery. A goniometer was utilized to obtain precise measurements for FE and ER. IR was measured as the uppermost vertebral level of the spine reached by the thumb upon rotation and was scaled in a standardized fashion as follows: rotation to the hip was denoted 0, sacrum was denoted 1, L5 vertebra was denoted 2, L4 vertebra was denoted 3, and so forth for the ascending vertebrae. PROMs included the American Shoulder and Elbow Surgeons (ASES) score, the Single Assessment Numerical Evaluation of the Shoulder (SANE) score, and a visual analog scale score for pain. These were collected prospectively, both prior to surgery and at a minimum of 2 years after surgery.

In addition to the above clinical evaluation, patients were called at a minimum of 2 years after surgery to answer a 7-question survey created by the authors. Questions were asked in a retrospective nature pertaining to the patients' engagement in sports during the 3 years prior to surgery and since their procedure, with the goal being to determine whether they had returned to sports and at what level compared to before surgery. The questions and answer options on the questionnaire are displayed in Table I. Patients were asked which sports they played within 3 years prior to surgery (question 2) and of those sports, which they considered to be their top/favorite (question 3). They were subsequently grouped for analysis based on the demand levels of their respective sports, as seen in the footnote of Table I. The demand levels of the various sports included were assigned based on our perception of shoulder demand and sport-specific movement modifiability.

Statistical analysis

Descriptive statistics were performed for the study population and expressed as mean and standard deviation (SD) or percentage. A univariate analysis was used to assess differences between patients with a primary diagnosis of GHOA and those with a primary diagnosis of CTA/MRCT as well as between those who returned to sport at the same or a higher level and those who returned at a lower level or not at all. Depending on distributions, the *t*-test or Mann-Whitney *U* test was used for continuous variables and Pearson's chi-squared test or Fisher exact test was used for categorical variables. A binary logistic regression was performed to determine predictors for returning to sport after surgery. All statistical analyses were carried out using R statistical software (version 1.2.1335; R Foundation for Statistical Computing).

Results

We attempted to contact 380 patients with complete clinical follow-up in our registry, of which 178 were successfully

Table II – Demographic data of patients who underwent reverse total shoulder arthroplasty based on a surgical indication of GHOA or RCTA/MRCT.

Parameter	GHOA	RCTA/MRCT	*P* value
	n = 68	n = 38	
High intensity sport pre-op	13 (19.1%)	5 (13.2%)	.607
Returned to sports	65 (95.6%)	31 (81.6%)	.033*
Returned at a same or higher level	56 (82.4%)	28 (73.7%)	.420
Age (y)	71.8 ± 5.2	73.7 ± 7.2	.167
BMI	30.4 ± 6.3	28.3 ± 4.9	.059
Female sex	37 (54.4%)	20 (52.6%)	1.000
ASA			
1	3 (4.4%)	0	.470
2	48 (70.6%)	30 (78.9%)	
3	17 (25.0%)	8 (21.1%)	
History of prior shoulder surgery	14 (20.6%)	23 (60.5%)	<.001*

BMI, body mass index; *GHOA*, glenohumeral osteoarthritis; *RCTA*, rotator cuff tear arthropathy; *MRCT*, massive rotator cuff tear; *ASA*, American Society of Anesthesiologists score; *Pre-op*, preoperative.
* Represents statistical significance with alpha-risk set to 0.05; $x \pm s$ represents mean ± standard deviation; *n* (%) represents frequencies and proportions.

contacted after 3 phone call attempts. Of the 178 patients, 106 had participated in sports in the 3 years prior to surgery and were included in the final study cohort. Prior to surgery, 18 (17.0%) of these patients played a high/moderate-demand sport while 88 (83.0%) played a low-demand sport, which was determined by the sports categorization seen in the footnote of Table I. Furthermore, 57 (53.8%) of these patients were female and 49 (46.2%) were male. A primary diagnosis of GHOA was identified in 68 (64.2%) whereas a primary diagnosis of CTA or MRCT was identified in 38 (35.8%) patients. Of the 106 patients who played sports within 3 years of surgery, 96 (90.6%) did return to playing sports whereas 10 (9.4%) did not return to playing sports postoperatively. Of the patients who did return to sports, 84 (87.5%) returned at the same or higher level while 12 (12.5%) returned at a lower level.

The ability to return to sport was significantly higher in patients with GHOA compared to CTA/MRCT (95.6% vs. 81.6%; $P = .033$). There were no significant differences in patients with GHOA compared to those with CTA/MRCT regarding mean age (72 vs. 74; $P = .167$), body mass index (30.4 vs. 28.3; $P = .059$), female gender (54.4% vs. 52.6%; $P = 1.000$), and ASA score ($P = .470$) (Table II). Patients with CTA/MRCT had a significantly higher percentage of prior surgeries compared to those patients with GHOA (20.6% vs. 60.5%; $P < .001$). There were no significant differences in the percentage of patients playing high intensity sports preoperatively in GHOA compared to CTA/MRCT cohorts (19.1% vs. 13.2%; $P = .607$) (Table II). Logistic regression showed that a diagnosis of GHOA was a significant predictor of returning to sports while controlling for the intensity of the sport (odds ratio = 6.3; $P = .017$) (Table III).

Compared to patients returning at the same or higher level of athletic activity, patients who either did not return to sports or did so at a lower level demonstrated higher preoperative pain ($P = .007$), lower postoperative SANE scores ($P = .027$), lower preoperative and postoperative ASES scores ($P = .004$ and $P = .016$, respectively), less preoperative and postoperative FE ($P = .037$ and $P = .019$, respectively), lower postoperative ER ($P = .004$), and lower preoperative IR ($P = .027$) (Table IV).

Table III – Multivariate logistic regression using GHOA and sport intensity to predict returning to sports after reverse total shoulder arthroplasty.

Factor	OR (95% CI)	*P* value
High intensity sport	0.18 (0.04-0.83)	.028*
Primary diagnosis of GHOA	6.3 (1.4-29.0)	.017*

OR, odds ratio; *CI*, confidence interval; *GHOA*, glenohumeral osteoarthritis.
* Represents statistical significance with alpha-risk set to 0.05.

Discussion

Patients with a primary diagnosis of GHOA were able to return to sports at a significantly higher rate compared to those patients with CTA/MRCT following primary RTSA. Moreover, GHOA was found to be a significant predictor of return to sport on logistic regression analysis. The ability of patients with GHOA to return to sports after RTSA in this current study was not only higher than what is previously reported in the literature,[13,17,18] but it is comparable to the literature evaluating return to sport after anatomic TSA.[12,13,16] This suggests that the indication for RTSA is an important predictor of a patient's ability to return to sports, and as such, patients should be counseled accordingly.

As physicians, it is important to understand patient goals and counsel patients preoperatively so that we can appropriately guide expectations postoperatively. A frequent question that is asked by patients undergoing shoulder arthroplasty is whether they will be able to return to the activities they enjoy. Kolling et al[9] found that 42% of surveyed patients reported that returning to previous sporting activities was an important expectation of theirs after RTSA. Henn et al[7] prospectively

Table IV – Clinical outcomes based on whether the patient returned to sport at the same or higher level vs. at a lower level or not at all following reverse total shoulder arthroplasty.

Parameter	Return to sports status:		*P* value
	Same or higher level	Lower level or not at all	
	n = 84	n = 22	
Pain			
Pre	5.0 ± 2.3	6.7 ± 2.6	.007*
Post	0.5 ± 1.0	1.1 ± 1.6	.180
Change	−4.5 ± 2.5	−5.7 ± 3.3	.031*
SANE			
Pre	32.1 ± 19.7	26.3 ± 24.0	.309
Post	88.2 ± 16.5	82.1 ± 14.6	.027*
Change	56.1 ± 23.5	55.8 ± 25.3	.957
ASES			
Pre	43.0 ± 16.6	29.5 ± 18.7	.004*
Post	87.1 ± 12.3	79.9 ± 14.4	.016*
Change	44.2 ± 20.1	50.3 ± 23.1	.261
Forward elevation			
Pre	94 ± 26	79 ± 31	.037*
Post	142 ± 17	129 ± 21	.019*
Change	47 ± 26	51 ± 31	.613
External rotation			
Pre	28 ± 15	25 ± 15	.456
Post	55 ± 22	41 ± 17	.004*
Change	27 ± 25	17 ± 17	.027*
Internal rotation			
Pre	1.3 ± 1.8	0.5 ± 0.9	.027*
Post	3.8 ± 2.4	2.9 ± 2.0	.085
Change	2.5 ± 2.5	2.5 ± 1.9	.984

RTSA, reverse total shoulder arthroplasty; *SANE*, Single Assessment Numerical Evaluation of the Shoulder score; *ASES*, American Shoulder and Elbow Surgeons score.

* Represents statistical significance; x ± s represents mean ± standard deviation.

evaluated preoperative patient expectations in patients undergoing RTSA and found that 74%-78% of patients reported improvement in ability to exercise, participate in sports, or participate in recreational activities as very or somewhat important to them. They also noted that younger patients had higher expectations regarding postoperative exercise and participation in sports. This topic has been shown to be an important factor when evaluating patient satisfaction, as studies have shown that satisfaction is strongly associated with the ability to return to sporting activity after arthroplasty.[19]

Recent literature has consistently reported improved ability to return to sports after anatomic TSA compared to RTSA.[1,10] In a systematic review of 13 studies, Lui et al found that 93% of patients undergoing TSA returned to sport compared to 75% of patients undergoing RTSA. Furthermore, they looked specifically at 7 studies that stratified patients based on preoperative diagnosis and found that patients with GHOA had the highest rate of return to sport (91.1%) compared to patients with CTA (83.0%). However, the authors admit that the results are confounded by the fact that the majority of these patients with GHOA underwent TSA rather than RTSA. Similarly, a systematic review and meta-analysis in 2017 found that approximately 77% of patients undergoing RTSA returned to sport, which is lower than that of TSA and hemiarthroplasty. They suggested that this was likely due to the specific patient population which typically undergoes RTSA, includes elderly patients, patients with worse shoulder function and biomechanics, and patients with RCTs.[1]

Expanding indications for RTSA now routinely include patients with primary GHOA. In a recent study, Best et al[2] found that approximately 33% of RTSAs are now being performed for a primary diagnosis of GHOA. Kirsch et al[8] evaluated outcomes after RTSA and TSA for patients with a primary diagnosis of GHOA and found that there were no significant differences in short-term PROMs, but that postoperative ROM was better after TSA. While studies have shown similar short-term outcomes for patients with GHOA undergoing TSA vs. RTSA, no studies have adequately evaluated the impact that preoperative diagnosis has on ability to return to sport after RTSA.[14] Previously mentioned studies found that patients have higher rates of return to sport after TSA compared to RTSA, but the TSA cohort also had higher percentage of patients with a primary diagnosis of GHOA, which may have confounded the data.[10] These studies, along with the emergence of performing RTSA for a primary diagnosis of GHOA, highlight the importance of delineating potential differences in ability to return to sport based on preoperative diagnosis instead of solely the procedure being performed.

Multiple studies have previously evaluated the ability to return to sporting activities following RTSA.[1,3-6,9-11,13,17,18] In a systematic review including 11 studies evaluating return to sport following RTSA, results showed that 60%-86% of patients returned to sport and that the complication rate following return to sport is low in the short- and medium-term follow-up periods, but long-term follow-up studies have not been completed.[11] Another systematic review including 6 studies and 457 patients found that the mean return to sport after RTSA was 79% at an average of 5.3 months postoperatively.[4] The level of sports participation postoperatively had improved in 39.6% of patients, remained unchanged in 55.2% of patients, and worsened in only 7.9% of patients. Davey et al specifically looked at the influence of type of sport and found that after RTSA, sport-specific return to sport rates included 94.4% for joggers, 74.3% for swimmers, 69.7% for cyclists, 66.7% for golfers, and 50% for tennis players with an overall return-to-sport rate of 71.4%. Overall, their study supported returning to sport after RTSA for patients wishing to participate in nonoverhead sports but found that results were less reliable for patients hoping to return to overhead sports such as tennis, swimming, and golf.[3]

The results of our study demonstrate a high rate of return to sport postoperatively, with an overall 90.6% of patients in our study who played sports preoperatively being able to return to sports after RTSA. Notably, these values are higher than in previously cited studies for RTSA and are consistent with return-to-sport numbers in TSA studies.[1,10] This is likely secondary to the inclusion of a significant number of patients with GHOA. Based on these findings, patients can be counseled that return to sport after RTSA is both a realistic goal and common occurrence. More specifically, though our novel results show that preoperative patient diagnosis has a significant effect on ability to return to sports postoperatively. We

found that patients with a preoperative diagnosis of GHOA had a significantly higher chance of return to sports (95.6% vs. 81.6%; $P = .033$) and trended toward an increased likelihood of returning to the sport at the same or higher level (82.4% vs. 73.7%; $P = .420$) compared to patients with a primary diagnosis of CTA/MRCT undergoing RTSA.

This study has several limitations. The biggest limitation is the recall bias that results from the retrospective collection of sport participation and activity level through questionnaires. Another limitation is that this is a retrospective study, although all PROMs (ASES, visual analog scale, and SANE) were collected prospectively. As this study was performed retrospectively, we were not able to contact all patients in the registry that fell within the study period. Although the 380 patients we attempted to contact represented >75% of the registry patients who had surgery during the study period, all of whom had complete follow-ups, we were only able to successfully contact 178. This limits the accuracy of the study given that we were unable to contact and collect responses to the sports participation questionnaire for the additional 202 eligible patients. Lastly, all data were collected from a single surgeon's experience with a practice that has evolved to utilizing RTSA more frequently for patients with primary GHOA so these results may not be generalizable.

Future studies should continue to evaluate the effect of preoperative modifiable and nonmodifiable risk factors on ability to return to sport postoperatively. If risk factors are modifiable, then the risk vs. benefit should be discussed regarding the possibility of delaying surgery to optimize patients preoperatively in the hopes of improving future ability to return to sporting activities. If risk factors are nonmodifiable, as in the case of primary diagnosis, then the data can be used to counsel patients regarding postoperative expectations. Additionally, future studies should assess the surgical satisfaction of patients based on whether they were able to return to sport after RTSA and at which level compared to before surgery.

Conclusion

Patients with a primary diagnosis of GHOA demonstrate significantly higher ability to return to sport after primary RTSA compared to those patients with CTA/MRCT. This study provides valuable new data showing that preoperative diagnosis, preoperative pain and function, and postoperative function have a significant effect on the likelihood of returning to sports postoperatively after RTSA. This data can be utilized to counsel patients preoperatively and to manage expectations after RTSA. Further research should be carried out to evaluate other factors, both modifiable and nonmodifiable, that impact one's ability to return to sport after RTSA so that patients can be optimized preoperatively and maximize their chances of meeting their goals postoperatively.

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