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Indication matters: effect of indication on clinical outcome following reverse total shoulder arthroplasty—a multicenter study

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Background: As the utilization and success of reverse total shoulder arthroplasty (RTSA) have continued to grow, so have its surgical indications. Despite the adoption of RTSA for the treatment of glenohumeral osteoarthritis (GHOA) with an intact rotator cuff and irreparable massive rotator cuff tears (MCTs) without arthritis, the literature remains sparse regarding the differential outcomes after RTSA among these varying indications. Thus, the purpose of this study was to examine the postoperative clinical outcomes of RTSA based on indication.

Methods: A retrospective review of 2 large institutional databases was performed to identify all patients who underwent RTSA between 2015 and 2019 with minimum 2-year follow-up. Patients were stratified by indication into 3 cohorts: GHOA, rotator cuff tear arthropathy (CTA), and MCT. Baseline demographic characteristics were collected to determine differences between the 3 cohorts. Clinical outcomes were measured preoperatively and postoperatively, including active range of motion, American Shoulder and Elbow Surgeons (ASES) score, Single Assessment Numeric Evaluation score, and visual analog scale pain score. Multivariate linear regression was performed to determine the factors independently predictive of the postoperative ASES score.

Results: A total of 625 patients (383 with GHOA, 164 with CTA, and 78 with MCTs) with a mean follow-up period of 33.4 months were included in the analysis. Patients with GHOA had superior ASES scores (85.6 ± 15.7 vs. 76.6 ± 20.8 in CTA cohort [$P < .001$] and 75.9 ± 19.9 in MCT cohort [$P < .001$]), Single Assessment Numeric Evaluation scores (86 ± 20.9 vs. 76.7 ± 24.1 in CTA cohort [$P < .001$] and 74.2 ± 25.3 in MCT cohort [$P < .001$]), and visual analog scale pain scores (median [interquartile range], 0.0 [0.0-1.0] vs. 0.0 [0.0-2.0] in CTA cohort [$P < .001$] and 0.0 [0.0-2.0] in MCT cohort [$P < .001$]) postoperatively. Postoperative active forward elevation ($P < .001$) and improvement in active external rotation ($P < .001$) were greatest in the GHOA cohort compared with other indications. Multivariate linear regression demonstrated that the factors independently associated with the postoperative ASES score included a diagnosis of GHOA (β coefficient, 7.557 [$P < .001$]), preoperative ASES score (β coefficient, 0.114 [$P = .009$]), female sex (β coefficient, −4.476 [$P = .002$]), history of surgery (β coefficient, −3.957 [$P = .018$]), and postoperative complication (β coefficient, −13.550 [$P < .001$]).

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Conclusion: RTSA for the treatment of GHOA generally has superior patient-reported and functional outcomes when compared with CTA and MCTs without arthritis. Long-term follow-up is needed to identify the lasting implications of such outcome differences.
Level of evidence: Level III; Retrospective Cohort Comparison; Prognosis Study

Keywords: Reverse shoulder arthroplasty; indication; glenohumeral osteoarthritis; rotator cuff tear arthropathy; massive rotator cuff tear; patient-reported outcome measures; minimal clinically important difference; substantial clinical benefit

As the utilization of reverse total shoulder arthroplasty (RTSA) has continued to steadily increase, indications for RTSA have concomitantly expanded.[3,5,19,10] Initially a surgical procedure described for the treatment of rotator cuff tear arthropathy (CTA) in elderly, low-demand individuals, RTSA is now used by surgeons in several other clinical scenarios, such as the management of proximal humeral fractures and malunions, glenohumeral osteoarthritis (GHOA), revision arthroplasty, and massive rotator cuff tears (MCTs) without arthritis.[5]

MCTs in patients without arthritis remain a challenging dilemma with controversial treatment options.[9] Although joint-preserving options are abundant, including superior capsular reconstruction, subacromial balloon spacer placement, and tendon transfer, RTSA is also a commonly used option in appropriately indicated patients.[1,16] RTSA effectively restores the mechanics of the glenohumeral joint in cases of MCTs, which cause a derangement in the force couple required for a stable fulcrum of glenohumeral motion.[18] Despite RTSA demonstrating improvement in pain and function in MCTs,[17] the literature is sparse with respect to the differential outcomes after RTSA for this indication relative to other common indications such as CTA or GHOA.[7]

The indications for RTSA have also expanded to include treatment of patients without rotator cuff pathology, such as those with primary GHOA. Historically, patients with advanced GHOA and an intact rotator cuff with failure of nonoperative treatment have undergone anatomic total shoulder arthroplasty. However, the success of RTSA in improving pain and restoring function led to increasing the surgical indications to include these patients, particularly those with eccentric glenoid deformity in whom polyethylene glenoid loosening would be of concern.[4,22] Furthermore, several studies have found RTSA and anatomic total shoulder arthroplasty to have comparable short-term outcomes in patients with GHOA with an intact rotator cuff[15,22] and have suggested that RTSA may result in more predictable longevity in cases of severe glenoid deformity.[6] As such, a recent report found that nearly one-third of all RTSAs in the United States are performed to treat GHOA with an intact rotator cuff.[2] Despite the widespread utilization of RTSA for the treatment of GHOA with an intact rotator cuff and MCTs without arthritis, few studies have evaluated the indication-specific outcomes of RTSA for these indications.[8,16,19]

Thus, the purpose of this study was to examine postoperative clinical outcome scores based on RTSA indication. We hypothesized that both objective patient-reported outcome measures (PROMs) and functional outcomes including active range of motion (AROM) would differ based on the indication for RTSA as stratified into 3 cohorts: GHOA with an intact rotator cuff, CTA, and MCT without arthritis.

Methods

Patient selection

We performed a retrospective cohort study using prospectively collected data from the surgical outcome databases (OBERD, Columbia, MO, USA; CareSense, Conshohocken, PA, USA) of 2 independent medical centers to identify consecutive patients who underwent primary RTSA between 2015 and 2019. The surgical procedures were performed by 2 high-volume, fellowship-trained shoulder surgeons, contributing 457 patients (A.J.) and 168 patients (J.C.L.). Patients were included in the study if they underwent primary RTSA for GHOA with an intact rotator cuff, CTA, or MCTs without glenohumeral arthritis (as confirmed on computed tomography scans and intraoperatively). All patients underwent preoperative computed tomography scans to assess glenoid morphology. The decision to proceed with RTSA in patients with type B2 or B3 glenoids was made at the surgeon's discretion. Patients were excluded from the study if they underwent a prior ipsilateral shoulder arthroplasty, had indications other than the aforementioned diagnoses (proximal humeral fracture, fracture sequelae, avascular necrosis, post-capsulorrhaphy arthropathy, and so on), had a history of ipsilateral shoulder infection, or had incomplete follow-up. All patients were required to have complete preoperative clinical outcomes and postoperative clinical outcomes at a minimum of 2 years. The DJO AltiVate Reverse prosthesis (Lewisville, TX, USA) was used in all cases.

Surgical technique

All surgical procedures were performed by 1 of 2 surgeons who used general anesthesia and an interscalene nerve block (when possible). A standard deltopectoral approach was performed in all cases. A subscapularis peel was performed, and whenever possible, repair to the lesser tuberosity was performed with transosseous sutures at the conclusion of the case. The supraspinatus was kept in continuity whenever possible. A lateralized glenosphere was used in all cases. No augmented baseplates or glenoid bone grafting was required. Mild corrective reaming was performed; however, the baseplate was left retroverted in an attempt to maximize baseplate coverage and fixation while minimizing glenoid reaming.

Clinical outcome assessment

Patient demographic characteristics, including age, sex, body mass index, American Society of Anesthesiologists comorbidity score, history of diabetes, smoking status, thyroid disease, rheumatoid arthritis, and prior ipsilateral shoulder surgery, were obtained and recorded. Active shoulder ROM, including forward elevation (FE), external rotation (ER), and internal rotation (IR) were measured preoperatively and at each postoperative visit. All range-of-motion measurements were recorded with the patient standing. ER was measured with the arm at 0° of abduction and elbow at 90° of flexion. Both FE and ER were measured with a traditional goniometer. IR was measured based on the uppermost vertebral level of the spine reached by the thumb of the examined arm. IR levels were recoded using a standardized scale, as described by Levy et al[12]: buttock or greater trochanter, 2; sacrum to L4, 4; L3 to L1, 6; T12 to T8, 8; and T7 to T1, 10. PROMs, including the American Shoulder and Elbow Surgeons (ASES) score, Single Assessment Numeric Evaluation (SANE) score, and visual analog scale (VAS) pain score, were prospectively recorded for all patients preoperatively and at each follow-up visit.

Statistical analysis

Postoperative ASES score was the primary outcome measure of the study. Secondary outcomes included postoperative shoulder AROM, SANE score, and VAS pain score; improvement in the ASES score, SANE score, and VAS pain score from preoperatively to postoperatively; percentage of patients who reached the minimal clinically important difference (MCID) and substantial clinical benefit (SCB) for the ASES score; and complications. Univariate analysis using 1-way analysis of variance was performed to compare baseline demographic and clinical features across patients. This testing was also conducted to compare postoperative AROM and PROMs between cohorts. The MCID and SCB thresholds for RTSA were previously defined by Simovitch et al.[20,21] Post hoc analyses were performed to compare cohorts head-to-head if significantly different values were noted via an initial analysis-of-variance test. All univariate testing, including the post hoc analyses, underwent Bonferroni correction for multiple comparisons. A multivariate linear regression was performed for postoperative ASES score to control for the various confounders, including age, sex, history of ipsilateral shoulder surgery, and preoperative ASES score. The α risk was set a priori to .05 to represent statistical significance. All statistical analysis was performed using the R package (version 4.2.2; R Foundation for Statistical Computing, Vienna, Austria).

Results

A total of 625 patients were included in the final analysis. Of these patients, 383 were treated with RTSA for GHOA, 164 were treated for CTA, and 78 were treated for MCT. The mean follow-up period was not significantly different between cohorts: GHOA patients were seen on average at 33.3 months; CTA patients, 34.0 months; and MCT patients, 32.5 months ($P = .862$). There were no significant differences among the cohorts in terms of sex ($P = .992$). There were significant differences among the cohorts with respect to age and body mass index, as well as history of shoulder surgery. GHOA patients were significantly less likely to have undergone a prior operation than the patients in the other 2 cohorts (18.3% vs. 39.0% in CTA cohort [$P < .001$] and 37.2% in MCT cohort [$P < .001$]). There were no other significant differences in baseline demographic characteristics among the cohorts (Table I).

There were no differences in baseline PROMs between indications. Postoperatively, the VAS pain score was significantly lower in the GHOA cohort than in the CTA ($P < .001$) and MCT ($P = .006$) cohorts. Patients in the GHOA cohort had significantly better postoperative ASES and SANE scores than patients in the CTA ($P < .001$) and MCT ($P < .001$) cohorts, as well as significantly greater improvement in these PROMs from the preoperative to postoperative time points when compared with the CTA ($P < .001$) and MCT ($P < .001$) cohorts. Of special note, patients with CTA—the original and still most common indication for RTSA—had the smallest improvement in ASES and SANE scores compared with the other indications (Table II). There were differences among the cohorts with respect to reaching the MCID, with the CTA cohort achieving the MCID at the lowest rate (87.8% vs. 94.5% of GHOA cohort [$P = .006$] and 92.3% of MCT cohort [$P = .290$]). Patients in the GHOA cohort achieved the SCB at the highest rate compared with the other cohorts (87.2% vs. 75.6% of CTA cohort [$P < .001$] and 74.4% of MCT cohort [$P < .001$]).

There were several differences among the cohorts with respect to preoperative range of motion. Postoperative active FE was greatest in the GHOA cohort (mean active FE, 138° ± 18° in GHOA cohort vs. 127° ± 28° in CTA cohort [$P < .001$] and 127° ± 22° in MCT cohort [$P < .001$]), but improvement from preoperative values was similar among the 3 cohorts ($P = .690$). The GHOA cohort also demonstrated the greatest improvement in active ER compared with the other indications (28° ± 21° vs. 15° ± 23° in CTA cohort [$P < .001$] and 16° ± 23° in MCT cohort [$P < .001$]). The GHOA cohort had significantly greater improvement in IR compared with both the CTA cohort ($P < .001$) and the MCT cohort ($P = .037$). It is interesting to note that the MCT cohort had significantly greater preoperative and postoperative ER compared with the CTA cohort (31° ± 15° vs. 25° ± 19° preoperatively [$P = .032$] and 47° ± 18° vs. 40° ± 20° postoperatively [$P = .045$]), although change in ER did not differ between these groups ($P = .998$) (Table II).

Complication rates were significantly different among the cohorts, with the lowest complication rate seen in the GHOA cohort (3.9% vs. 9.1% in CTA cohort [$P = .024$]

Table I Patient demographic characteristics by indication

Parameter	GHOA (n = 383)	CTA (n = 164)	MCT without arthritis (n = 78)	*P* value
Female sex	231 (60.3)	98 (59.8)	47 (60.2)	.992
Age, yr	71.9 ± 6.2	72.8 ± 7.4	70.3 ± 8.7	.034*
BMI	31.0 ± 6.3	29.1 ± 5.4	29.2 ± 6.7	.002*
Follow-up, mo	33.3 ± 15.1	34.0 ± 17.8	32.5 ± 15.0	.862
ASA comorbidity score				
1	9 (2.3)	0	2 (2.6)	.270
2	268 (70.0)	109 (66.5)	50 (64.1)	
3	104 (27.2)	48 (29.3)	26 (33.3)	
4	1 (0.3)	1 (0.6)	0	
Diabetes				
No diabetes	329 (85.9)	138 (84.1)	69 (88.5)	.438
Type 1	4 (1.0)	5 (3.0)	0	
Type 2	50 (13.1)	21 (12.8)	9 (11.5)	
Smoking status				
Never	166 (43.3)	81 (49.4)	39 (50.0)	.100
Former	203 (53.0)	76 (46.3)	32 (41.0)	
Current	14 (3.7)	7 (4.3)	7 (9.0)	
Thyroid disorder	75 (19.6)	31 (18.9)	14 (17.9)	.940
Rheumatoid arthritis	23 (6.0)	14 (8.5)	7 (9.0)	.442
Prior surgery	70 (18.3)	64 (39.0)	29 (37.2)	<.001*

GHOA, glenohumeral osteoarthritis; *CTA*, rotator cuff tear arthropathy; *MCT*, massive rotator cuff tear; *BMI*, body mass index; *ASA*, American Society of Anesthesiologists.
Data are presented as mean ± standard deviation or number (percentage).
* Statistically significant with α risk of 0.05.

and 6.4% in MCT cohort [P = .357]). The complications experienced by patients in the GHOA cohort included acromial stress fracture (n = 4), nerve injury (n = 3), major medical complication following surgery (n = 3), intraoperative fracture (n = 2), ipsilateral cubital tunnel (n = 1), postoperative coracoid fracture (n = 1), and aseptic traumatic glenoid component loosening (n = 1). The complications experienced by CTA patients included acromial stress fracture (n = 8), dislocation (n = 3), scapular spine stress fracture (n = 1), hematoma (1), intraoperative fracture (n = 1), and periprosthetic joint infection (n = 1). The complications in the MCT cohort included acromial stress fracture (n = 1), dislocation (n = 1), postoperative neuropathy (n = 1), postoperative deltoid rupture (n = 1), and delayed wound healing (n = 1).

When controlling for confounders, linear regression modeling demonstrated that the factors independently associated with a higher postoperative ASES score were a diagnosis of GHOA (β coefficient, 7.557, with CTA as the reference [P < .001]) and higher preoperative ASES score (β coefficient, 0.114 [P = .009]) whereas female sex (β coefficient, −4.476 [P = .002]), history of surgery (β coefficient, −3.957 [P = .018]), and postoperative complication (β coefficient, −13.550 [P < .001]) were associated with lower postoperative ASES scores (Table III).

Discussion

The results of this study demonstrate that, among 3 common indications for primary RTSA, there are substantial and relevant clinical differences observed based on the specific indication for surgery. Most notably, GHOA patients with intact rotator cuffs have better functional outcomes and PROMs following RTSA than those with a diagnosis of CTA or MCTs without arthritis. These patients generally had the greatest improvements in ER and IR, the greatest postoperative FE, and the highest rates of meeting both the MCID and SCB. When controlling for potential confounders, a diagnosis of GHOA was also shown to be the strongest independent predictor of a higher postoperative ASES score.

There have been a handful of previous efforts that sought to stratify outcomes after RTSA by primary diagnosis. Recently, Saini et al[19] published a retrospective cohort study comparing the short-term vs. intermediate-term outcomes of nearly 200 patients with GHOA and intact rotator cuffs with a cohort of CTA patients. In accordance with our findings, their study demonstrated that a preoperative diagnosis of GHOA was associated with superior postoperative active FE and improvement in IR, as well as SANE, ASES, and VAS pain scores, to those in the CTA

Table II Comparison of clinical outcomes by indication

Parameter	GHOA (n = 383)	CTA (n = 164)	MCT without arthritis (n = 78)	P value per ANOVA[*]	P value per post hoc pair-wise comparison: GHOA vs. MCT without arthritis	CTA vs. MCT without arthritis	GHOA vs. CTA
Age, yr	71.9 ± 6.2	72.8 ± 7.4	70.3 ± 8.7	.034[†]	.136	.025[†]	.399
BMI	31.0 ± 6.3	29.1 ± 5.4	29.2 ± 6.7	.002[†]	.055	>.999	.005[†]
Follow-up period, mo	33.3 ± 15.1	34.0 ± 17.8	32.5 ± 15.0	.862	—	—	—
VAS pain score							
Preoperative	6.0 (5.0 to 8.0)	6.0 (4.0 to 8.0)	6.0 (4.6 to 8.0)	.878	—	—	—
Postoperative	0.0 (0.0 to 1.0)	0.0 (0.0 to 2.0)	0.0 (0.0 to 2.0)	<.001[†]	.006[†]	>.999	<.001[†]
Change	−5.0 (−7.0 to 0.0)	−3.0 (−6.0 to 2.0)	−3.0 (−6.0 to −1.6)	.020[†]	.225	>.999	.036[†]
SANE score							
Preoperative	31.6 ± 20.6	30.6 ± 20.9	28.6 ± 23.0	.499	—	—	—
Postoperative	86.4 ± 20.9	76.7 ± 24.1	74.2 ± 25.3	<.001[†]	<.001[†]	>.999	<.001[†]
Change	54.8 ± 29.9	46.1 ± 30.4	45.6 ± 31.4	.002[†]	.037[†]	.991	.006[†]
ASES score							
Preoperative	34.4 ± 15.4	34.6 ± 18.1	32.6 ± 17.6	.659	—	—	—
Postoperative	85.6 ± 15.7	76.6 ± 20.8	75.9 ± 19.9	<.001[†]	<.001[†]	.580	<.001[†]
Change	51.0 ± 21.6	42.0 ± 23.9	43.2 ± 24.0	<.001[†]	.015[†]	.923	<.001[†]
Forward elevation, °							
Preoperative	90 ± 26	79 ± 32	76 ± 37	<.001[†]	<.001[†]	.672	<.001[†]
Postoperative	138 ± 18	127 ± 28	127 ± 22	<.001[†]	<.001[†]	.981	<.001[†]
Change	48 ± 29	48 ± 33	51 ± 35	.690	—	—	—
External rotation, °							
Preoperative	25 ± 16	25 ± 19	31 ± 15	.013[†]	.011[†]	.032[†]	.988
Postoperative	52 ± 18	40 ± 20	47 ± 18	<.001[†]	.026[†]	.045[†]	<.001[†]
Change	28 ± 21	15 ± 23	16 ± 23	<.001[†]	<.001[†]	.998	<.001[†]
Internal rotation							
Preoperative	1.1 ± 1.9	2.2 ± 2.9	1.8 ± 2.8	<.001[†]	.016[†]	>.999	<.001[†]
Postoperative	3.6 ± 3.0	3.3 ± 3.1	3.3 ± 3.0	.147	—	—	—
Change	2.5 ± 3.3	1.1 ± 3.6	1.6 ± 3.9	<.001[†]	.037[†]	.423	<.001[†]

GHOA, glenohumeral osteoarthritis; *CTA*, rotator cuff tear arthropathy; *MCT*, massive rotator cuff tear; *ANOVA*, analysis of variance; *BMI*, body mass index; *VAS*, visual analog scale; *SANE*, Single Assessment Numeric Evaluation; *ASES*, American Shoulder and Elbow Surgeons.

Data are presented as mean ± standard deviation or median (interquartile range). Internal rotation was measured based on the uppermost vertebral level of the spine reached by the thumb: buttock or greater trochanter, 2; sacrum to L4, 4; L3 to L1, 6; T12 to T8, 8; and T7 to T1, 10.

[*] The Kruskal-Wallis test was used if the data were not normally distributed.

[†] Statistically significant with α risk of 0.05.

cohort. Our study provides a useful expansion on these results, studying nearly twice as many GHOA patients (n = 383), in addition to including patients with MCTs without degenerative changes as a third point of comparison. Waterman et al[24] retrospectively evaluated a matched cohort of patients undergoing RTSA for GHOA with an intact rotator cuff and patients with CTA, finding that patients with GHOA and an intact rotator cuff had significantly greater active ER than those with CTA, whereas ASES scores, VAS pain scores, SANE scores, and active FE were similar between the cohorts. On the contrary, in our study, patients with GHOA had superior outcomes to both CTA and MCT patients with respect to VAS pain, ASES, and SANE scores and AROM in multiple planes. It is possible that these differences in outcomes are related to the relative power of our study, with 383 patients in our GHOA cohort compared with 43 patients in the GHOA group in the study by Waterman et al. Alternatively, there were subtle differences in baseline preoperative demographic characteristics in our population that could contribute to these findings (Table I); however, given the generally similar baseline preoperative function and PROMs among our cohorts, as well as the strong relationship between a diagnosis of GHOA and the postoperative ASES score through regression analysis, we suspect that this is a less likely explanation (Tables I-III).

Although GHOA with an intact rotator cuff showed superior outcomes compared with either of the other

Table III Linear regression model: predictors of postoperative ASES score

Parameter	β coefficient	Standard β (95% CI)	*P* value
Diagnosis (reference category: CTA)			
MCT without arthritis	−0.376	−0.021 (−0.279 to 0.238)	.876
GHOA	7.557	0.414 (0.232 to 0.596)	<.001*
Age	0.172	0.065 (−0.016 to 0.146)	.116
BMI	0.012	0.004 (−0.075 to 0.083)	.920
Preoperative ASES score	0.114	0.103 (0.026 to 0.180)	.009*
Postoperative complication	−13.550	−0.742 (−1.066 to −0.418)	<.001*
Follow-up period	−0.070	−0.061 (−0.136 to 0.015)	.114
Prior surgery	−3.957	−0.217 (−0.396 to −0.037)	.018*
Smoking status (reference category: never)			
Previous	0.415	0.023 (−0.131 to 0.176)	.772
Current	−1.480	−0.081 (−0.461 to 0.299)	.675
ASA comorbidity score (reference category: comorbidity score of 2)			
1	1.861	0.102 (−0.471 to 0.675)	.727
3	−3.018	−0.165 (−0.340 to 0.009)	.063
4	0.157	0.009 (−1.305 to 1.323)	.990
Female sex	−4.476	−0.245 (−0.401 to −0.089)	.002*

ASES, American Shoulder and Elbow Surgeons; *CI*, confidence interval; *CTA*, rotator cuff tear arthropathy; *MCT*, massive rotator cuff tear; *GHOA*, glenohumeral osteoarthritis; *BMI*, body mass index; *ASA*, American Society of Anesthesiologists.
* Statistically significant with α risk of 0.05.

diagnoses studied, this study provides important outcome-related information pertaining to RTSA for MCTs without arthritis. As the natural history of untreated MCTs is a progression to CTA, comparing the outcomes of these 2 indications is interesting as they represent different time points on the spectrum of the same disease process. Kääb et al[11] evaluated 151 RTSAs for outcome differences between various Hamada grades. They found no difference in clinical outcomes between patients with low-grade disease (MCTs without arthritis) and those with high-grade disease (CTA) at short- to mid-term follow-up, concluding that there was no relationship between Hamada grade severity and outcome after RTSA. Similarly, De La Selle et al[7] found no differences between patients with MCTs and those with CTA at long-term follow-up after RTSA. Our results are generally in accordance with those of the aforementioned studies, as MCT patients without arthritis generally showed comparable preoperative and postoperative VAS pain, ASES, and SANE scores and AROM to CTA patients. Exceptions to this trend were noted in postoperative active ER, which was on average 7° higher in the MCT cohort ($P = .045$, Table II). These findings suggest that, regardless of the degree of arthritis seen in the cuff-deficient shoulder, patients can expect reliable improvements in pain and function following RTSA, with the possibility of increased postoperative ER if RTSA is performed prior to the development of arthritic changes. Of note, the generally higher complication rate observed in CTA patients (9.1%) may be related to the higher rate of acromial stress fractures seen in patients with this diagnosis (4.9% [8 of 164]) compared with the other indications (1.0% [4 of 383] in GHOA cohort and 1.3% [1 of 78] in MCT cohort), a trend similarly reported by Saini et al.[19]

The 3 cohorts evaluated in this study demonstrate important differences in pathoanatomy. In cuff-deficient patients undergoing RTSA, joint degeneration is a result of altered joint reactive forces from the lack of functioning rotator cuff musculature. Similarly, although MCT patients have little to no degenerative joint disease, they can be thought of as pathologically similar to early-stage CTA patients, with altered glenohumeral joint biomechanics due to a dysfunctional rotator cuff driving the symptomatology and presentation. On the contrary, in primary GHOA with an intact rotator cuff, various theories exist as to the pathophysiology of the progressive degenerative process, although the etiology of the disease is still unknown. An emerging theory is that the degeneration is driven by an anterior capsular contracture, resulting in posterior subluxation and altered joint mechanics.[14,23] These differences may be important in understanding the potential for variable outcomes after RTSA depending on the diagnosis. From our results, we hypothesize that the rotator cuff is an important dynamic stabilizer in patients after RTSA, providing balanced force coupling that enhances the improvement in AROM, as well as PROMs, following RTSA.

There are several notable strengths of this study. Although several studies have evaluated the effect of indication on outcomes after RTSA, this is the first study to date to compare the outcomes of patients with GHOA with an intact rotator cuff, MCTs without arthritis, and CTA.[7,13,19,24] Although this study was retrospective in that the research question was posed after data collection, the surgical outcome data were prospectively collected, helping to minimize selection and recall bias. As previously highlighted, this study contains a larger series of patients than prior studies reporting on the comparative effect of indication on outcomes after RTSA, which strengthens the power of these data. The multicenter nature of this study is also an important strength, as single-surgeon studies may be limited in external validity.

Despite these strengths, certain limitations of our study should be noted. First, this is a retrospective study that is prone to the flaws inherent to any non–prospectively performed review. Although the subscapularis was repaired at the end of all cases, when possible, the likelihood of a reparable subscapularis may be higher in patients with an intact rotator cuff preoperatively, possibly affecting clinical outcomes. Owing to limitations in the data, we were unable to perform a robust postoperative radiographic analysis and therefore did not report any radiographic outcomes or specific glenoid Walch classifications of each arthritis subgroup preoperatively. Additionally, our initial comparison among cohorts was not controlled for specific confounders, such as age and history of surgery, which could be relevant to overall postoperative outcomes. However, we sought to address this by performing an additional linear regression analysis for postoperative ASES score to help offset this limitation in our results.

Conclusion

RTSA for the treatment of primary GHOA with an intact rotator cuff generally has superior patient-reported and functional outcomes when compared with RTSA for CTA or MCTs without arthritis. Long-term follow-up will be useful to establish implant longevity for GHOA patients, as well as the lasting implications of the aforementioned outcome differences.

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