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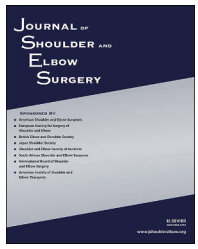

Reverse and anatomic total shoulder arthroplasty for glenohumeral osteoarthritis: a propensity-matched comparison at early and midterm follow-up

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ABSTRACT

Background: Reverse shoulder arthroplasty (rTSA) and anatomic total shoulder arthroplasty (aTSA) treat glenohumeral osteoarthritis (GHOA) with comparable early outcomes. Given increasing utilization of rTSA for GHOA, we sought to evaluate outcomes of rTSA and aTSA for GHOA at early and midterm follow-up.

Methods: A retrospective propensity-matched cohort study of patients undergoing aTSA and rTSA for GHOA with early and midterm follow-up was performed. Matching included age, sex, body mass index, preoperative American Shoulder and Elbow Surgeons (ASES) score, preoperative forward elevation, and Walch glenoid morphology. Baseline patient characteristics, range of motion, ASES, Single Assessment Numeric Evaluation (SANE), visual analog scale (VAS) for pain scores, complications and revision rTSAs/aTSAs were assessed at early and midterm follow-up.

Results: One hundred twenty-two patients (61 per group) were included with early and midterm follow-up. Baseline characteristics, comorbidities, preoperative ASES, SANE, VAS pain scores, and range of motion were similar ($P > .05$). Both groups showed significant improvements in ASES, SANE, and VAS scores at both time points ($P < .001$); >96% achieved minimal clinically important difference for ASES. While more aTSA patients met substantial clinical benefit early (95.1% vs. 80.3%, $P = .027$); there was no statistically significant difference at midterm follow-up ($P = .074$). aTSA patients had better early internal (5.0 vs. 3.3, $P < .001$) and external rotation (63.0° vs. 57.0°, $P = .036$), with no difference at midterm follow-up. Complication rates were similar; however, aTSA had more revisions and radiolucencies.

Conclusion: aTSA and rTSA yield similar clinical outcomes for GHOA at early and midterm follow-up. Early differences in substantial clinical benefit, internal, and external rotation with aTSA diminished by midterm follow-up. Complication rates were similar between

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the cohorts. One patient in the aTSA group was revised to rTSA and no patients with primary rTSA required revision. While rTSA and aTSA result in excellent clinical outcomes, longer follow-up is needed to determine durability.

Level of evidence: Level III; Retrospective Cohort Comparison; Treatment Study

Keywords: Reverse total shoulder arthroplasty (rTSA); anatomic total shoulder arthroplasty (aTSA); glenohumeral osteoarthritis (GHOA); postoperative outcome; propensity matched cohorts; rotator cuff arthropathy (RCA)

Anatomic total shoulder arthroplasty (aTSA) is the historic gold standard for glenohumeral osteoarthritis (GHOA), resulting in excellent clinical outcomes in the majority of patients.[7,21,22,27] Long-term success is limited by glenoid component loosening and rotator cuff failure. Excessive posterior glenoid bone loss may increase the risk of osteolysis around the component,[10,29] leading to poor patient-reported outcomes.[17] Rotator cuff failure is associated with worse functional and clinical outcomes.[1,15,16,32] Revision to reverse shoulder arthroplasty (rTSA) leads to worse outcomes, decreased satisfaction, and increased complications compared to primary arthroplasty.[26]

Due to questionable long-term durability of aTSA, surgeons considered rTSA for GHOA. Since Mizuno et al first reported rTSA for GHOA in 2013, clinical results and patient satisfaction are promising.[19] And, as utilization has expanded, rTSA has superior outcomes for GHOA compared to other indications.[8,24,30] As a result, there has been a substantial increase in rTSA, and GHOA is the most common indication globally.[9,17,18]

Recent comparative studies of aTSA and rTSA show similar early outcomes.[4,11] In a matched-cohort comparison of 2-year outcomes of rTSA and aTSA for GHOA, both demonstrated excellent outcomes; aTSA had increased early range of motion (ROM) compared to rTSA.[12] A study by Cuff et al comparing early and midterm outcomes of aTSA and rTSA for GHOA with eccentric glenoid wear revealed improved ROM and clinical outcomes early with aTSA; however, by 7 years, the outcomes of aTSA deteriorated while rTSA improved. By final follow-up, rTSA had higher patient satisfaction, functional outcome scores, and lower revision rates.[6]

These findings highlight the need for longer follow-up to evaluate durability and clinical outcomes of aTSA and rTSA for GHOA. Therefore, we sought to compare early and midterm clinical and functional outcomes, revisions and complications in a matched series of patients undergoing rTSA or aTSA for GHOA. We hypothesized that early functional and clinical outcomes would be comparable and maintained at midterm follow-up.

Materials and methods

Patient selection

A retrospective review of a prospectively-maintained institutional database [Outcomes Based Electronic Research Database (OBERD); Columbia, MO, USA] was conducted following IRB approval to identify patients who underwent primary shoulder arthroplasty between 2015 and 2020. This database has >75% clinical follow-up; and patients are followed postoperatively at multiple time points including at 2 weeks, 6 weeks, 3 months, 6 months, 1 year, 2 years, 5 years, and 10 years. In this study, "early" follow-up occurs at 1-2 years and "midterm" follow-up at 4-6 years. All patients had clinical evaluations at both time points. All procedures were performed by a single high-volume fellowship-trained shoulder surgeon (A.J.) at a large private institution. Inclusion criteria: (1) primary aTSA or rTSA for GHOA with intact rotator cuff, (2) early and midterm clinical follow-up, (3) complete pre- and postoperative outcomes scores, (4) preoperative magnetic resonance imaging or computed tomography (CT) to assess rotator cuff integrity and glenoid morphology via modified Walch classification system.[2] Exclusion criteria: (1) diagnosis other than GHOA, (2) rotator cuff tear, (3) incomplete follow-up, (4) prior ipsilateral shoulder surgery (except arthroscopic debridement). Race was not a criteria in the OBERD database and could not be included.

Matching

Patients meeting inclusion/exclusion criteria were propensity score-matched 1:1 based on age, sex, body mass index (BMI), modified Walch classification, preoperative American Shoulder and Elbow Surgeons (ASES) score, and preoperative forward elevation. Matching used a greedy, nearest-neighbor algorithm with a 0.2-caliper width to prevent poor matches, enhancing precision and controlling variance within the sample set, with an optimal caliper range of 0.2 to 0.5 times the standard deviation of the logit.[3] The final matched cohort included 122 patients (61 per group).

Surgical technique

All procedures were performed by the senior surgeon (A.J.) under general anesthesia in the beach chair position with an interscalene block. A deltopectoral approach was performed, and the biceps tendon sewn to the pectoralis major. For rTSA, the subscapularis was peeled and repaired with simple and Mason-Allen transosseous sutures. A standardized prosthesis was used (AltiVate Reverse; DJO Surgical, Austin, TX, USA). Female patients received a 32-4-mm lateralized glenosphere and male patients received a 32 + 10 mm or 36 + 6 mm glenosphere based on the surgeon's experience and preoperative planning. An uncemented inlay standard-length humeral component was implanted. For aTSA, stemless or stemmed implants were used based on surgeon experience and preference. A lesser tuberosity osteotomy was performed and repaired using the same suture technique described with

rTSA. A cemented, all-polyethylene glenoid component was used with backside reaming. Excessive posterior wear was corrected with preferential reaming, and augmented components (Tornier Perform Anatomic Augmented Glenoid, Bloomington, MN) were used in 2 cases. Stemmed and stemless humeral components were used. Postoperative rehabilitation protocol included: restricted ROM in a sling for 6 weeks with progressive ROM and strengthening via physician-directed home therapy beginning at 2 weeks.

Clinical outcome assessment

Patient demographic data were obtained from the electronic medical record. Clinical assessments including active shoulder ROM (FE, ER, IR) were performed by the senior surgeon (A.J.) preoperatively, at early and midterm follow-up. FE and ER were measured with a goniometer. IR was measured by the highest vertebral level reached by the thumb point system[28]: 0-buttocks/hip, 1-sacrum, 2-L5, 3-L4, etc. Patient-reported outcome measures (PROMs), including ASES, Single Assessment Numeric Evaluation (SANE) and visual analog scale (VAS) for pain scores were collected preoperatively and at both postoperative time points. Complications and revisions were recorded.

Radiographic evaluation

Glenoid morphology was assessed by 2 fellowship-trained shoulder surgeons (A.J., K.L.) and classified using axillary radiographs based on the modified Walch classification by consensus.[2] All patients had preoperative anteroposterior, axillary radiographs, CT and magnetic resonance imaging. Radiographs were obtained at both follow-ups and radiolucent lines were assessed and graded by 2 fellowship-trained shoulder surgeons (A.J., K.L.) by consensus. aTSA was evaluated for glenoid lucencies via the Lazarus classification system[14]; rTSA was evaluated for radiolucent lines around the baseplate, screws, or component shift.

Statistical analysis

Descriptive statistics were calculated for each cohort (mean, standard deviation (SD), median, interquartile range (IQR), or percentage). Univariate analysis compared baseline demographics, comorbidities, and clinical outcomes between cohorts and timepoints using *T*-tests, Mann-Whitney *U*, Chi-Squared, and Fisher Exact tests. Improvements in ASES were assessed via minimal clinically important difference (MCID) (10.4) and substantial clinical benefit (SCB) (28.3) thresholds.[16,23] Statistical significance was set at an alpha level of 0.05. Analyses were conducted using R software (version 4.2.2, Auckland, New Zealand).

Results

The initial query of the institutional database identified 546 aTSA patients and 1,310 rTSA patients. Patients were included if they had primary glenohumeral osteoarthritis with an intact rotator cuff and had complete follow-up at both time points. Patients were excluded if they had surgery for any indication other than GHOA, or had incomplete follow-up or incomplete outcome scores at both early and midterm follow-up. The majority of excluded patients from the initial database query included those who had not had midterm follow-up yet. After applying inclusion and exclusion criteria, 129 aTSA and 133 rTSA patients were eligible for 1:1 propensity score matching by age, sex, BMI, modified Walch classification, preoperative ASES score and preoperative forward elevation. The final matched cohort included 122 patients (61 per group) with a mean early and midterm follow-up of 22.2 ± 5.7 months and 60.0 ± 4.4 months for rTSA and 21.7 ± 4.6 months and 60.2 ± 5.8 months for aTSA ($P > .05$) (Fig. 1). No significant differences were found in demographics, comorbidities, or prior surgeries ($P > .05$) (Table I).

There were no significant differences in VAS pain, SANE, or ASES scores between the groups at preoperative, early or midterm follow-up ($P > .05$). Baseline-to-postoperative changes in all PROMs did not significantly differ at early and midterm follow-up ($P > .05$) (Table II, Fig. 2). The ASES MCID was achieved by 59 patients in both groups at early follow-up (96.7%, $P > .99$) and 60 rTSA (98.4%) vs. 59 aTSA (96.7%) at midterm follow-up ($P > .99$). Early, more aTSA patients achieved SCB (95.1%) vs. rTSA (80.3%) ($P = .027$); no difference was observed at midterm follow-up ($P = .074$) (Tables II and III).

Preoperative ROM was similar between groups (Table II, Fig. 2). Both cohorts demonstrated significant postoperative improvements in forward elevation, with no differences between aTSA and rTSA at either early or midterm follow-up (Table II, Fig. 2). aTSA patients showed greater external and internal rotation early after surgery; however, these differences were not present at midterm. The overall magnitude of improvement in rotational motion from baseline to final follow-up was comparable between groups (Tables II and III, Fig. 2).

Radiolucent lines occurred in 3 rTSA patients: 2 without failure or complications; 1 failure but preserved alignment and function. In the aTSA group, radiolucent lines occurred in 22 of 61 patients at early follow-up (36.1%) and 28 of 61 by midterm follow-up (45.9%). 21/28 (75%) had low-grade lucencies (Lazarus grade 0, 1 or 2) that did not progress significantly by midterm follow-up. One patient had Grade 5 lucencies at both-time points but no clinical dysfunction or revision. Six patients had low-grade lucencies early that progressed to high-grade lucencies (Lazarus grade 3, 4 or 5) by midterm follow-up; none required revision.

Complications occurred in 2 (3.3%) rTSA patients and 2 (3.3%) aTSA patients ($P > .99$) (Fig. 3). In the rTSA group, 1 patient sustained a Type 1 acromial stress fracture and was successfully treated nonoperatively. At midterm follow-up this patient had no pain, SANE 96, ASES 100, FE 150°, ER 60°, and IR L5 was satisfied. The second rTSA complication included a patient with baseplate lucencies, broken screws and maintained alignment. This patient had no pain, preserved motion and function and was treated nonoperatively. In the aTSA group, one patient sustained an atraumatic rotator cuff tear, necessitating revision to rTSA (Fig. 3). The other aTSA complication included subscapularis insufficiency, which was treated nonoperatively. At final follow-up, this patient had no pain, SANE 100, ASES 88, FE 130°, ER 50°, IR L5,

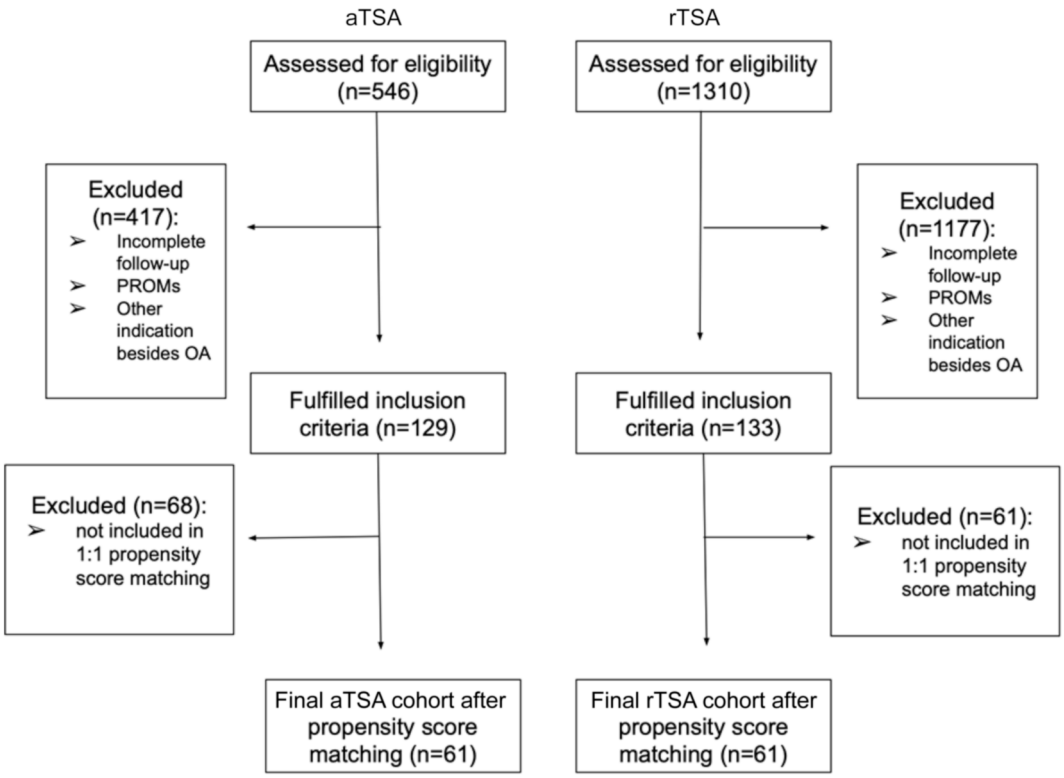

Figure 1 – Flow diagram demonstrating patient inclusion and exclusion criteria for the rTSA and TSA cohorts. *TSA*, total shoulder arthroplasty; *rTSA*, reverse shoulder arthroplasty.

and was satisfied. No rTSA patients underwent revision. One aTSA patient underwent revision to rTSA for rotator cuff insufficiency (Table I).

Discussion

This study demonstrated similar early and midterm outcomes of aTSA and rTSA for GHOA. Both groups showed significant improvements in ASES, VAS pain, and SANE scores, suggesting that both treatments may successfully improve pain and satisfaction at early and midterm follow-up. Importantly, >96% of patients met ASES MCID at both time points in both groups. aTSA patients showed greater improvements in SCB early, though there was no statistically significant difference at midterm follow-up; however, both groups achieved significant improvements from baseline and early follow-up. This may suggest that aTSA patients may experience benefits early and plateau after a few years, whereas rTSA patients may make gradual gains over time.

This study demonstrated significant functional improvements with both rTSA and aTSA. Forward elevation, external, and internal rotation improved in both compared to baseline and had similar gains in forward elevation at both time points with comparable degree of improvement from baseline to final follow-up. aTSA patients exhibited greater early improvements in external rotation (63° vs. 57°), though the clinical significance of this difference is unclear. By midterm follow-up, both had similar external rotation and comparable overall degree of improvement from baseline.

Many studies show greater internal rotation with aTSA compared to rTSA.[16,25,28,29] Our study demonstrated better early internal rotation with aTSA, reaching a higher lumbar level than rTSA. This difference of less than 2 lumbar levels may be of unclear clinical significance; some patients may note improved activities of daily living and hygiene behaviors while others may not experience the same clinical impact. Importantly, aTSA showed greater improvement in IR from baseline to early follow-up and from early to midterm follow-up; however, by final follow-up, the overall difference narrowed as patients in the rTSA group continued to improve. Both groups improved a similar amount from baseline to final follow-up. These findings align with several studies demonstrating better IR with aTSA at early follow-up, but we demonstrate that this difference is not maintained later.[5,6,12] Taken together, these early functional and clinical differences with aTSA suggest that aTSA patients may recover faster, while patients who undergo rTSA have a steadier recovery with ultimately similar endpoints by midterm follow-up.

Three rTSAs had radiographic lucencies with 1 baseplate failure. In contrast, over a third of aTSAs had low-grade lucencies at early follow-up and nearly half at midterm follow-up, though none required revision for glenoid failure. These findings largely align with the literature, with radiolucencies from 9%-73% and variable clinical significance.[13] While Schoch et al noted worse PROMs in 35% of aTSAs with low-

Table I – Comparing baseline characteristics and demographics of the matched rTSA and TSA cohorts

Parameter	rTSA for GHOA n = 61	aTSA for GHOA n = 61	P value
Age ♦	67.1 ± 4.1	66.7 ± 4.9	.573
Sex ♦			
Male	40.1% (25)	45.9% (28)	.715
Female	59.0% (36)	54.0% (33)	
BMI ♦	30.1 ± 6.0	30.0 ± 6.4	.946
Follow-up A (mo)	22.2 ± 5.7	21.7 ± 4.6	.597
Follow-up B (mo)	60.0 ± 4.4	60.2 ± 5.8	.797
Walch classification ♦			
A1/A2	39.3% (24)	44.3% (27)	.753
B1/B2/B3	57.4% (35)	54.1% (33)	
C	0.0% (0)	0.0% (0)	
D	3.1% (2)	1.5% (1)	
ASA comorbidity score >2	14.8% (9)	19.3% (12)	.602
Comorbidities			
Hypertension	55.7% (34)	50.8% (31)	.717
Hypercholesterolemia	34.4% (21)	31.1% (19)	.847
Diabetes mellitus	9.8% (6)	4.9% (3)	.489
Depression	16.4% (10)	21.3% (13)	.643
Thyroid disease	16.4% (10)	14.7% (9)	>.999
Obesity	26.2% (16)	14.8% (9)	.178
History of smoking	45.9% (28)	54.0% (33)	.469
Prior ipsilateral shoulder surgery	21.3% (13)	19.7% (12)	>.999
Complications	3.3% (2)	3.3% (2)	>.999
Hardware failure	(1)		
Failed rotator cuff		(1)	
Acromial stress fracture	(1)		
Instability		(1)	
Rate of revision needed	0.0% (0)	1.6% (1)	>.999
TSA to RSA		(1)	

rTSA, reverse shoulder arthroplasty; *TSA*, total shoulder arthroplasty; *RCA*, rotator cuff arthropathy; *GHOA*, glenohumeral osteoarthritis; *BMI*, body mass index; *ASA*, American Society of Anesthesiologists; *follow-up A*, 2 year postoperative length of follow up; *follow up B*, 5 year postoperative length of follow up.
♦ Variables used to propensity score match rTSA and aTSA patients.

Table II – Comparing clinical outcomes of the matched rTSA and TSA cohorts

Parameter	RSA n = 61	TSA n = 61	P value
ASES			
Preoperative ♦	41.4 ± 17.6	38.9 ± 15.8	.403
Postoperative A	87.3 ± 15.4	89.4 ± 11.3	.977
Postoperative B	87.6 ± 16.1	89.8 ± 13.8	.404
Change A Pre - 2	45.8 ± 20.2	50.5 ± 17.5	.175
Change B 2 - 5	−0.28 ± 12.3	−0.35 ± 12.9	.973
Change C Pre - 5	46.2 ± 20.4	50.9 ± 19.8	.197
% reached MCID A	96.7% (59)	96.7% (59)	>.999
% reached SCB A	80.3% (49)	95.1% (58)	.027*
% reached MCID C	98.4% (60)	96.7% (59)	>.999
% reached SCB C	78.7% (48)	91.8% (56)	.074
Pain			
Preoperative	5.3 ± 2.3	5.5 ± 2.1	.622
Postoperative A	0.7 ± 1.5	0.6 ± 1.3	.650
Postoperative B	0.9 ± 1.9	0.6 ± 1.5	.156
Change A Pre - 2	−4.5 ± 2.5	−4.9 ± 2.0	.427
Change B 2 - 5	−0.2 ± 1.8	−0.0 ± 1.5	.551
Change C Pre - 5	−4.3 ± 2.7	−4.8 ± 2.3	.279
SANE			
Preoperative	34.1 ± 22.3	36.2 ± 18.7	.615
Postoperative A	87.0 ± 20.1	89.5 ± 14.8	.919
Postoperative B	89.7 ± 13.9	87.5 ± 15.1	.274
Change A Pre - 2	52.6 ± 30.6	53.5 ± 24.5	.967
Change B 2 - 5	−2.70 ± 20.0	2.02 ± 18.5	.322
Change C Pre - 5	55.3 ± 25.4	51.3 ± 22.9	.398
FE			
Preoperative ♦	97.5 ± 23.5	98.2 ± 23.2	.812
Postoperative A	144.1 ± 19.8	146.4 ± 12.6	.663
Postoperative B	145.1 ± 14.0	147.0 ± 14.5	.154
Change A Pre - 2	46.6 ± 28.3	48.2 ± 24.9	.748
Change B 2 - 5	−0.97 ± 21.3	−0.66 ± 14.9	.926
Change C Pre - 5	47.6 ± 26.9	48.9 ± 23.4	.785
ER			
Preoperative	27.8 ± 10.6	27.4 ± 8.8	.904
Postoperative A	57.0 ± 17.4	63.0 ± 13.6	**.036***
Postoperative B	60.0 ± 16.5	63.7 ± 16.3	.214
Change A Pre - 2	29.3 ± 17.2	35.7 ± 15.6	.053
Change B 2 - 5	−3.03 ± 14.5	−0.66 ± 13.5	.351
Change C Pre - 5	32.3 ± 16.1	36.3 ± 16.8	.180
IR			
Preoperative	0.8 ± 1.0	0.8 ± 1.6	.467
Postoperative A	3.3 ± 2.3	5.0 ± 2.4	**<.001***
Postoperative B	4.1 ± 2.7	4.5 ± 2.6	.385
Change A Pre - 2	2.5 ± 2.2	4.2 ± 2.6	**<.001***
Change B 2 - 5	−0.9 ± 2.7	0.5 ± 2.4	**.007***
Change C Pre - 5	3.3 ± 2.8	3.7 ± 2.6	.477

rTSA, reverse shoulder arthroplasty; *TSA*, total shoulder arthroplasty; *GHOA*, glenohumeral osteoarthritis; *RCA*, rotator cuff arthropathy; *ASES*, American Shoulder and Elbow Surgeons Score; *SANE*, Single Assessment Numeric Evaluation; *FE*, forward elevation; *ER*, external rotation; *IR*, internal rotation; *MCID*, minimal clinically important difference; *SCB*, substantial clinical benefit.
♦ Variables used to propensity score match rTSA and aTSA patients.

grade lucencies, we found no clinical deterioration or glenoid-sided revisions.[24]

Complication rates were similar in the aTSA and rTSA groups at final follow-up (3.3%); however, the types differed. rTSA complications included 1 acromial stress fracture and 1 baseplate failure; both were treated nonoperatively without significant consequence. Therefore, we present a 1.6% acromial stress fracture risk by midterm follow-up. This is lower than reported in the literature; however, our study excluded rotator cuff pathology, a known risk factor for stress fractures.[20] aTSA complications included rotator cuff failure requiring revision to rTSA and subscapularis insufficiency treated nonoperatively with good outcome. These findings are in concordance with the literature, as rotator cuff failure is the most common cause of revision (9%-26%).[1,31] Larger sample sizes are needed to determine whether there are significant differences in revision rates between aTSA and rTSA which would speak to potential advantages in durability.

The differences in internal rotation observed between early and midterm follow-up are likely multifactorial. Preoperative IR, prosthetic design features, and soft-tissue balance all influence postoperative IR, and these factors may contribute to the continued improvement seen in the rTSA cohort over time. Additionally, changes in scapulothoracic kinematics and gradual muscular adaptation may enhance functional internal rotation as patients progress through

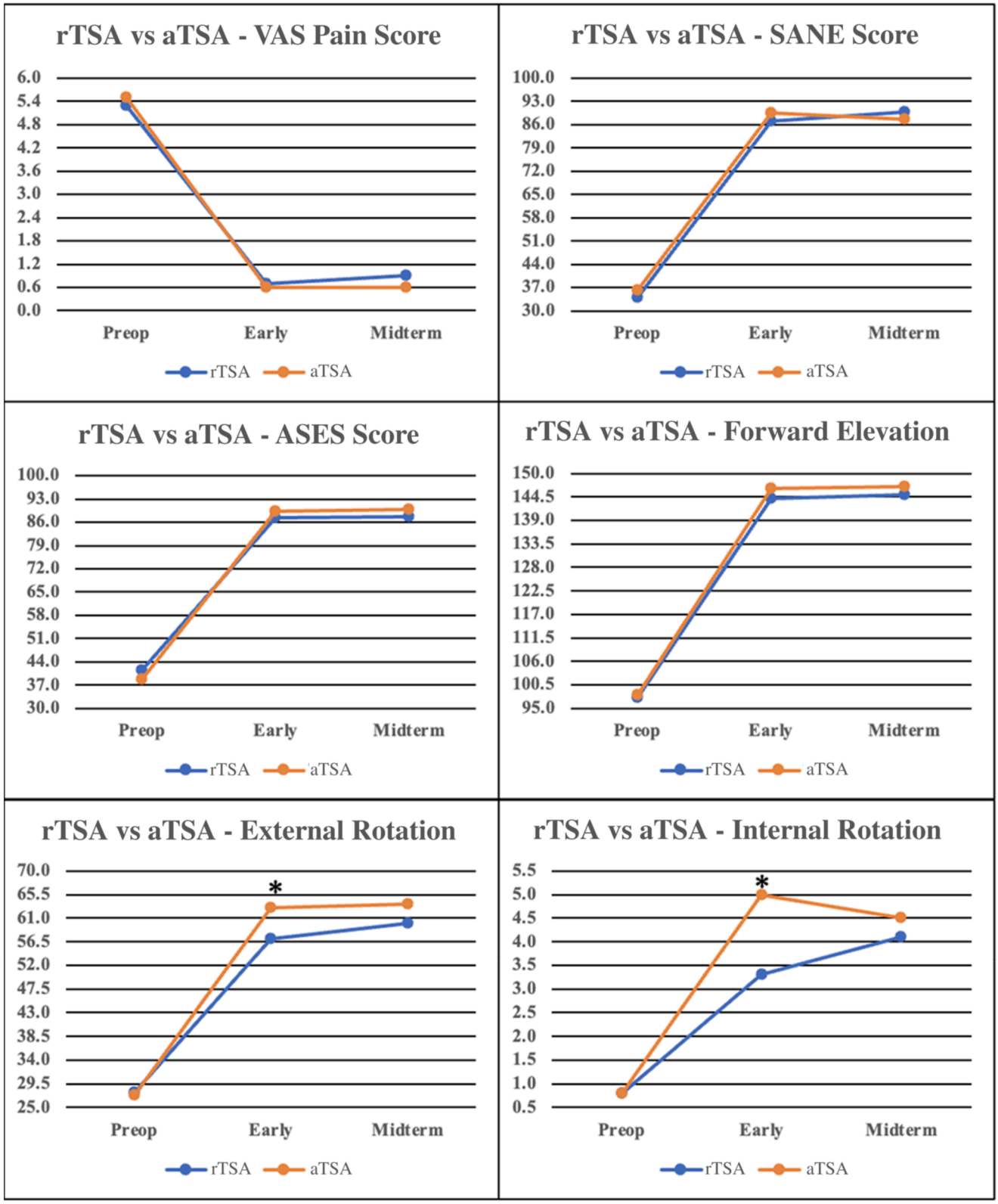

Figure 2 – Comparing clinical outcomes of matched rTSA and TSA cohorts. *TSA*, total shoulder arthroplasty; *rTSA*, reverse shoulder arthroplasty.

Table III – Changes in outcomes over time within the matched RSA and TSA cohorts

Parameter	Preoperative	2 yr	5 yr	*P* value pre to 2	*P* value pre to 5	*P* value 2 to 5 yr
RSA for GHOA						
ASES	41.4 ± 17.6	87.3 ± 15.4	87.6 ± 16.1	**<.001***	**<.001***	.922
% reached MCID		96.7% (59)	98.4% (60)			
% reached SCB		80.3% (49)	78.7% (48)			
Pain	5.3 ± 2.3	0.7 ± 1.5	0.9 ± 1.9	**<.001***	**<.001***	.521
SANE	34.1 ± 22.3	87.0 ± 20.1	89.7 ± 13.9	**<.001***	**<.001***	.390
FE	97.5 ± 23.5	144.1 ± 19.8	145.1 ± 14.0	**<.001***	**<.001***	.756
ER	27.8 ± 10.6	57.0 ± 17.4	60.0 ± 16.5	**<.001***	**<.001***	.324
IR	0.8 ± 1.0	3.3 ± 2.3	4.1 ± 2.7	**<.001***	**<.001***	.089
TSA for GHOA						
ASES	38.9 ± 15.8	89.4 ± 11.3	89.8 ± 13.8	**<.001***	**<.001***	.876
% reached MCID		98.5% (64)	96.7% (59)			
% reached SCB		95.1% (58)	91.8% (56)			
Pain	5.5 ± 2.1	0.6 ± 1.3	0.6 ± 1.5	**<.001***	**<.001***	.922
SANE	36.2 ± 18.7	89.5 ± 14.8	87.5 ± 15.1	**<.001***	**<.001***	.457
FE	98.2 ± 23.2	146.4 ± 12.6	147.0 ± 14.5	**<.001***	**<.001***	.790
ER	27.4 ± 8.8	63.0 ± 13.6	63.7 ± 16.3	**<.001***	**<.001***	.810
IR	0.8 ± 1.6	5.0 ± 2.4	4.5 ± 2.6	**<.001***	**<.001***	

rTSA, reverse shoulder arthroplasty; *TSA*, total shoulder arthroplasty; *GHOA*, glenohumeral osteoarthritis; *RCA*, rotator cuff arthropathy; *ASES*, American Shoulder and Elbow Surgeons Score; *SANE*, Single Assessment Numerical Evaluation; *FE*, forward elevation; *ER*, external rotation; *IR*, internal rotation; *MCID*, minimal clinically important difference; *SCB*, substantial clinical benefit.

* Statistical significance with alpha risk of 0.05.

rehabilitation. Osseous remodeling or reduced bony impingement over time may also contribute to improved motion. Conversely, the slight decline in IR observed in the aTSA cohort between early and midterm follow-up may reflect soft-tissue changes despite an intact cuff. It is also important to note that the ASES score may not fully capture functional internal rotation highlighting the need for future studies using more IR-specific outcome measures.

This study has several limitations. It reflects a single surgeon's experience, which may limit generalizability and introduce confirmation bias due to evolving indications for rTSA. Additionally, ROM was assessed clinically by the treating surgeon, which may introduce measurement variability. While this method reflects common clinical practice, the use of motion-capture–based assessment could improve the precision and objectivity of pre- and postoperative mobility measurements. Propensity score matching for age, sex, BMI, preoperative ASES score, forward elevation and Walch glenoid morphology minimizes bias. While Walch classification was used as a surrogate for severity of glenoid morphology, exact measurements of glenoid version and inclination were not used in this analysis. While clinical outcomes were prospectively collected, the retrospective design may introduce bias. Both stemless and stemmed aTSA were included based on the surgeon's experience and preference which could possibly introduce confounding. Because this study includes only one reverse implant design from a single surgeon's practice, the findings may not be generalizable to other prosthesis designs. In addition, a power analysis was not able to be performed given this statistical model; therefore, there is a risk of Type II error. Further, the sample size could produce a Type II error for non-significant findings, and could create fragility in the data for findings that are statistically significant. Finally, this study involves multiple comparisons across several outcome domains, which increases the potential for type I error. No multiplicity correction was applied due to the exploratory nature of the study; thus, these findings should be interpreted with caution and considered hypothesis-generating rather than confirmatory. Despite these limitations, we present a large consecutive series directly comparing aTSA and rTSA outcomes for GHOA with early and midterm follow-up. Matching for Walch glenoid morphology minimizes bias in more severe glenoid cases, which represents a more balanced perspective of rTSA versus aTSA in GHOA.

These results build upon existing literature, including a propensity-matched cohort comparison of outcomes of rTSA and aTSA for cuff-intact GHOA by Kirsch et al in 2022. The authors demonstrated similar clinical outcomes with rTSA and aTSA and improved early range of motion with aTSA at average 2-year follow-up. Our study demonstrated similar findings with comparable clinical results between rTSA and aTSA and increased motion with aTSA at early follow-up, but also includes midterm follow-up and the comparison of clinical and functional outcomes between early and midterm follow-up. Importantly, our study shows that differences in range of motion of aTSA early are not significantly different from range of motion of rTSA at midterm follow-up, and the overall improvements made from baseline to early and midterm follow-up are comparable between the 2 groups which is a novel finding.

Conclusion

Overall, aTSA shows better early clinical and functional outcomes, while rTSA patients make steady improvement, and both achieve comparable midterm results. Importantly, both provide effective pain relief, functional improvement and

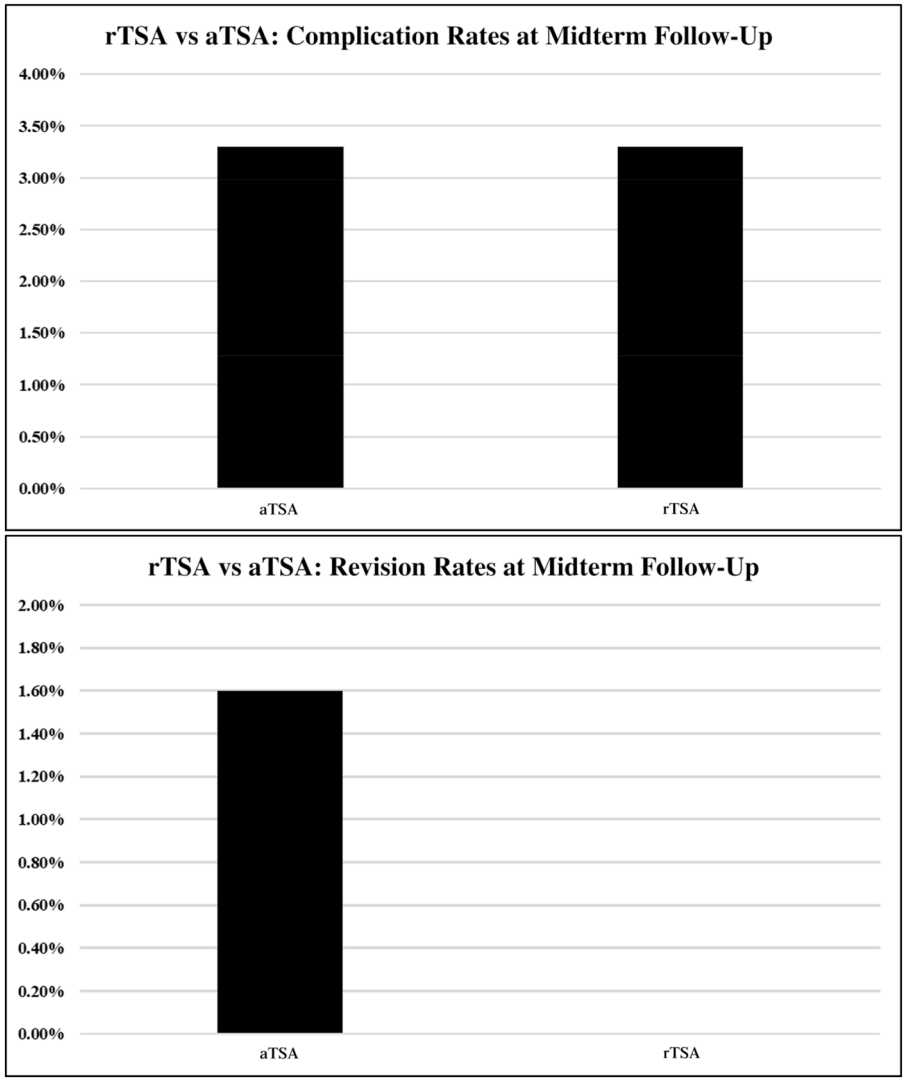

Figure 3 – Comparing complication and revision rates of matched rTSA and TSA cohorts. *TSA*, total shoulder arthroplasty; *rTSA*, reverse shoulder arthroplasty.

patient satisfaction, with similar complication rates. As rTSA indications expand, understanding the clinical and functional outcomes, risks, and complications is paramount. These findings highlight the excellent outcomes, low complication, and revision rates with rTSA for GHOA. Longer follow-up data are needed to better assess the risks, benefits, complications, and longevity of aTSA and rTSA in treating GHOA.

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