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Salvage reverse total shoulder arthroplasty for failed anatomic total shoulder arthroplasty: a cohort analysis

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Background: Reverse total shoulder arthroplasty (RTSA) as a revision procedure for failed anatomic total shoulder arthroplasty (TSA) is increasing in incidence. The purpose of this study was to analyze the results of RTSA as a revision salvage procedure for failed TSA and identify factors that influenced those outcomes.

Methods: All anatomic TSAs that were revised to RTSAs in adult patients, under the care of 2 senior surgeons at a single academic center from 2006 to 2018, were queried and reviewed. Cases in which hemiarthroplasty or RTSA was revised to RTSA were excluded. Electronic medical records and survey databases were reviewed for each subject. Demographic and surgical details were reviewed and analyzed with descriptive statistics. Preoperative and postoperative range of motion (ROM) including active forward elevation and active external rotation were evaluated. Patient-reported outcome surveys including the American Shoulder and Elbow Surgeons survey, Single Assessment Numeric Evaluation, and visual analog scale for pain were collected and analyzed. Improvement in ROM and outcome survey measures was assessed with 2-sample *t* tests. Complication and reoperation rates were analyzed with descriptive statistics.

Results: A total of 75 patients (32 men and 43 women) were available for analysis at a mean of 22.3 months. The subjects were aged 60.3 ± 11.3 years at the time of TSA and 64.6 ± 9.7 years at the time of RTSA. The average period between TSA and RTSA was 4.3 years. The 3 most common indications for revision RTSA were painful arthroplasty (n = 62, 82.7%), rotator cuff failure (n = 56, 74.7%), and unstable arthroplasty (n = 25, 33.3%), but the majority of patients had multiple indications for surgery (n = 69, 92%). Significant improvements were found in all outcome measures from the time of failed TSA diagnosis to most recent follow-up after salvage RTSA with the exception of active external rotation: American Shoulder and Elbow Surgeons score, 39 ± 15 preoperatively vs. 62 ± 25 postoperatively; Single Assessment Numeric Evaluation, 27 ± 23 vs. 60 ± 30; visual analog scale pain score, 5 ± 2 vs. 3 ± 3; and active forward elevation, 79° ± 41° vs. 128° ± 33°. Major complications occurred in 21 patients (28.4%) after salvage RTSA, and 9 (12%) underwent reoperation.

Conclusions: RTSA for failed TSA can improve pain, function, and quality-of-life measures in patients with various TSA failure etiologies. However, postoperative ROM and patient-reported outcomes do not reach the values seen in the primary RTSA population.

This study was approved by the Rush University Medical Center Institutional Review Board (no. 16010802-IRB01) on February 17, 2016.

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The number of anatomic total shoulder arthroplasties (TSAs) performed worldwide continues to increase as surgical indications expand and implant survival improves.[4] Surgical case selection can include patients of younger ages[8,9] and increasing surgical indications than when the procedure was first developed. As such, more TSAs are being performed worldwide, lending a greater need for revision options for failed TSA.

Reverse total shoulder arthroplasty (RTSA) can be a viable option for various failure modes of TSA. Previous studies have examined RTSA as a salvage option for unstable TSA,[6] implant component loosening,[1] and rotator cuff failure, as well as pain and infection.[5] Most studies have reported poorer outcomes and increased complication and reoperation rates than with primary RTSA.[10] However, studies of this patient population have had small sample sizes.

The purpose of this study was to examine the functional and patient-reported outcomes (PROs) of RTSA as a revision salvage procedure for failed TSA for multiple failure etiologies. The secondary purpose of this study was to identify demographic and surgical factors that influenced those outcomes.

Methods

Patient selection and data collection

This was a retrospective case series of all adult patients in whom primary TSA was revised to RTSA under the care of 2 senior surgeons at a single academic center from 2006 to 2018. Patients who underwent revision RTSA from primary hemiarthroplasty or primary RTSA were excluded.

Electronic medical records and survey databases were reviewed for demographic factors and surgical details including age at index TSA, age at revision RTSA, sex, comorbidities, surgical laterality, prior ipsilateral surgery before index TSA, surgeon, and TSA explant type. Explants were further classified as convertible TSA or nonconvertible TSA according to the manufacturers' technique guides. Operative reports were reviewed to determine the indication for revision RTSA listed by the senior surgeon. Indications were classified into the following categories: septic loosening, rotator cuff failure, painful arthroplasty, unstable arthroplasty, fracture, glenoid component loosening, humeral component loosening, or multiple indications. Reoperations and complications following revision RTSA were reviewed using electronic medical records.

Preoperative and postoperative active range of motion (ROM) was assessed as active forward elevation (AFE) and active external rotation (AER) with a goniometer during standard postoperative follow-up visits and recorded in a surgical database. Preoperative and postoperative outcome surveys given to patients as part of the standard of care, including the American Shoulder and Elbow Surgeons (ASES) survey, Single Assessment Numeric Evaluation (SANE), and visual analog scale (VAS) for pain, were collected in a database and extracted for this study. The preoperative scores obtained closest to revision RTSA and the postoperative scores obtained at most recent follow-up were extracted for this study.

Postoperative ROM and PROs were the primary outcomes of the study. Reoperation and complication rates were considered secondary outcomes. We classified major complications as those that required long-term intervention, required repeated operation, or had a significant impact on long-term outcome. Minor complications were those that were transient in nature and resolved with minimal intervention or those that were unrelated to the surgical procedure. The impact of the indication for RTSA on postoperative AFE was assessed. In addition, the use of convertible vs. nonconvertible TSA implants was considered a predictor of primary and secondary outcomes.

Statistical analysis

Descriptive statistics with means and proportions were used to summarize demographic and surgical variables. Improvement in ROM and PROs was assessed with the Wilcoxon signed rank test. The effect of the surgical indication for RTSA on postoperative AFE was assessed with the Mann-Whitney U test. Mann-Whitney U tests were also used to evaluate the impact of TSA type (convertible or nonconvertible) on continuous outcomes (AFE, AER, ASES score, SANE score, and VAS pain score). The Fisher exact test was used to evaluate the effect of convertible TSA on complications and reoperations. Stata software (version 12.1; StataCorp, College Station, TX, USA) was used for all statistical analyses, and the statistical significance threshold was set at $P < .05$.

Results

At an average of 22.3 ± 25.5 months (range, 1-137 months) of follow-up, 75 patients (32 men and 43 women) met the inclusion criteria and were included in the analysis. The patients were aged 60.3 ± 11.3 years at the time of TSA and 64.6 ± 9.7 years at the time of revision RTSA. The average time elapsed between TSA and RTSA was 4.3 years. The 3 most common indications for revision RTSA were painful arthroplasty (n = 62, 82.7%), rotator cuff

failure (n = 56, 74.7%), and unstable arthroplasty (n = 25, 33.3%). Implant loosening was also a common cause for revision RTSA: glenoid loosening (n = 24, 32%), septic loosening (n = 15, 20%), and humeral loosening (n = 11, 14.7%). The majority of patients in the series (n = 69, 92%) had multiple indications for revision RTSA, with painful arthroplasty being either a co-primary or secondary reason for revision RTSA in most cases. (Table I).

Patients experienced a statistically significant improvement in AFE from the preoperative (79° ± 41°) to postoperative (128° ± 33°) assessment ($P < .001$). Statistically significant improvements were also observed in the ASES score (39 ± 15 preoperatively vs. 62 ± 25 postoperatively, $P < .001$), SANE score (27 ± 23 vs. 60 ± 30, $P < .001$), and VAS pain score (5 ± 2 vs. 3 ± 3, $P = .002$). The only outcome measure for which a statistically significant improvement was not observed was AER ($P = .73$) (Table II). No RTSA indication was associated with a significantly different postoperative AFE with the exception of glenoid loosening. Patients undergoing RTSA for TSA with a loose glenoid component had significantly higher postoperative AFE ($P = .04$).

After revision RTSA, 21 patients (28.4%) experienced postoperative complications and 9 (12%) underwent a reoperation. Complications were divided into 2 main categories, major and minor (Tables III and IV). After revision RTSA, 8 patients (10.6%) experienced major complications (Table III) and 13 patients (17.3%) experienced minor complications (Table IV).

A variety of primary TSA implants were included in this study. The 4 most common were as follows: Zimmer Trabecular Metal (Warsaw, IN, USA), Arthrex Univers II (Naples, FL, USA), Zimmer Bigliani/Flatow, and Tornier Aequalis Press-Fit Primary (Edina, MN, USA) (Table V). There were 5 patients (7%) with convertible TSA systems. The use of convertible vs. nonconvertible TSA systems did not result in significant differences in postoperative ROM, PROs, complications, or reoperations.

Table I Baseline patient characteristics for revision RTSA for failed TSA

	Data
No. of shoulders	75
Age at TSA (range), yr	60.3 ± 11.3 (22-81)
Age at RTSA (range), yr	64.6 ± 9.7 (32-82)
Female sex, n (%)	43 (57.3)
Laterality: right, n (%)	39 (52)
Surgeon 1, n (%)	43 (57.3)
Surgeon 2, n (%)	32 (42.7)
Preoperative diagnosis, n (%)	
Painful arthroplasty	62 (82.7)
Rotator cuff failure	56 (74.7)
Unstable arthroplasty	25 (33.3)
Glenoid loosening	24 (32)
Septic loosening	15 (20)
Humeral loosening	11 (14.7)
Fracture	2 (2.7)
Multiple indications	69 (92)

TSA, anatomic total shoulder arthroplasty; *RTSA*, reverse total shoulder arthroplasty.

Table II Preoperative and postoperative active range of motion and patient-reported outcome measures

	Preoperative	Postoperative	*P* value
ASES score	39 ± 15	62 ± 25	<.001*
SANE score	27 ± 23	60 ± 30	<.001*
VAS pain score	5 ± 2	3 ± 3	.002*
Active forward elevation, °	79 ± 41	128 ± 33	<.001*
Active external rotation, °	38 ± 23	39 ± 13	.727

ASES, American Shoulder and Elbow Surgeons; *SANE*, Single Assessment Numeric Evaluation; *VAS*, visual analog scale.
* Statistically significant.

Table III Major complications of revision RTSA for failed TSA

Complication	n
Postoperative infection requiring surgery	3
Dislocated RTSA	1
Persistent pain: VAS pain score >5	1
Displaced glenosphere after fall	1
Persistent weakness	1
Pain with positive EMG findings	1

RTSA, reverse total shoulder arthroplasty; *TSA*, anatomic total shoulder arthroplasty; *VAS*, visual analog scale; *EMG*, electromyographic.

Discussion

With the greater utilization of TSA in recent years, identifying reliable salvage methods for different TSA failure modes and studying the mid-term outcomes of those salvage procedures have become increasingly important. In this study, we report on the mid-term outcomes of RTSA performed as a salvage operation for several different TSA failure types. This study shows that patients undergoing RTSA for failed TSA demonstrate significant improvements in ROM and PRO measures at mid-term follow-up. However, high rates of complications and reoperations were found in this patient population. This information proves valuable for the surgeon to counsel the patient regarding the expectations after undergoing revision.

Prior studies have proposed salvage procedure options for failed shoulder arthroplasty. Sheth et al[11] reported unpredictable results for failed TSA treated with

Table IV Minor complications of revision RTSA for failed TSA

Complication	n
Superficial infection managed with oral antibiotics	4
Acromial stress fracture	1
Global pain in trapezius and posterolateral shoulder	1
Incisional hematoma	1
Swelling and delayed recovery resulting from fall	1
Pain due to overuse	1
Carpal tunnel symptoms	1
Pain of cervical etiology	1
Anterior deltoid pain resolved with PT	1
Edema in hand resolved with OT	1

RTSA, reverse total shoulder arthroplasty; *TSA*, anatomic total shoulder arthroplasty; *PT*, physical therapy; *OT*, occupational therapy.

Table V Make and model of TSA systems in study

TSA make	TSA model	n
Zimmer	Trabecular Metal	13
Arthrex	Univers II	10
Zimmer	Bigliani/Flatow	9
Tornier	Aequalis Press-Fit Primary	7
Arthrex	Univers Apex	5
Biomet (Warsaw, IN, USA)	Bio-Modular	5
DePuy (Raynham, MA, USA)	Global Advantage Porocoat	5
Tornier	Aequalis Cemented Primary	5
DePuy	Global	2
Tornier	Ascend Flex	2
Biomet	Bi-Angular Total Shoulder Arthroplasty System	1
Biomet	Comprehensive	1
Biomet	Comprehensive Mini	1
DePuy	Conservative Anatomic Prosthesis	1
DePuy	Global UNITE Anatomic Platform	1
Exactech (Gainesville, FL, USA)	Equinoxe Press-Fit Primary	1
Exactech	Equinoxe Primary	1
Exactech	Total Shoulder	1
Smith & Nephew (Andover, MA, USA)	Cofield I	1
Tornier	Simpliciti Press-Fit	1
Missing	—	1

TSA, anatomic total shoulder arthroplasty.

revision TSA. Multiple interventions for failed TSA and hemiarthroplasty were studied by Gauci et al,[5] who reported that in most cases, RTSA was the final salvage operation performed. A number of smaller studies have been performed on revision RTSA for failed TSA.[2,6,13,14]

Most studies reported improvements in ROM and PRO scores but high rates of complications and reoperations after revision RTSA. Wagner et al[13] reported similar PRO scores and ROM in their older age cohort to those in our study, and our larger sample size allows for confirmation of expected PRO scores and ROM in this population. In a study focused on revision for rotator cuff failure or component loosening, similar improvements in PRO scores were observed.[12] Holschen et al[7] reported that the initial indication for anatomic shoulder arthroplasty influenced revision arthroplasty outcomes, which was not addressed in our study. Furthermore, it is expected that revision RTSA will not result in the consistent and higher functional improvement observed in primary RTSA.[3]

The strengths of this study include the larger sample size than in previous work and consistency in surgical technique as all cases were performed by 2 senior surgeons at a single academic center. A weakness of this study is the lack of longer-term follow-up, as well as the lack of a true matched control cohort. Furthermore, the small number of patients in this series with convertible TSA systems does not allow us to make any strong conclusions. As TSA designs continue to evolve and move toward more bone-sparing and stemless designs, future studies should focus on whether these designs impact outcomes after revision. In addition, as indications for RTSA as a primary procedure continue to increase, future studies should compare the results of primary RTSA to the results of revision TSA to RTSA.

Conclusion

RTSA for failed TSA can improve pain, function, and quality-of-life measures in patients with various TSA failure etiologies. However, postoperative ROM and PROs do not reach the values seen in the primary RTSA population and do come at a higher risk of postoperative complications.

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