RESEARCH ARTICLE

Revision of Anatomic Total Shoulder Arthroplasty to Hemiarthroplasty: Does it work?

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Abstract

Background: The projected increase in revision shoulder arthroplasty has increased interest in the outcomes of these procedures. Glenoid component removal and conversion to a hemiarthroplasty (HA) is an option for aseptic glenoid loosening after anatomic total shoulder arthroplasty (aTSA).

Methods: We identified patients who had undergone revision shoulder arthroplasty over a 15-year period. 17 patients met inclusion and exclusion criteria, and a retrospective chart review was conducted for pre-surgical and operative data. We contacted patients at a mean follow-up of 70 months from revision surgery for implant survival, reoperations and functional outcomes scores.

Results: Implant survival was estimated to be 88% at 2 years and 67% at 5 years. Mean ASES score for surviving implants was 58 ± 22. Mean SANE score was 54 ± 24, and mean VAS pain score was 3.5 ± 2.8. Mean SF-12 Mental and Physical scores were 46 ± 15 and 38 ± 10, respectively. Five patients (50% of those with surviving implants) reported being either very satisfied or satisfied with the status of their shoulder. There were complications in 6 patients (35%) and 5 patients (29%) required reoperation.

Conclusion: HA following failed aTSA due to glenoid loosening produced modest clinical results and satisfaction rates. Reverse arthroplasty may be a more reliable treatment strategy in this patient population.

Level of evidence: IV

Keywords: Aseptic glenoid loosening, Hemiarthroplasty, Implant survival, Revision arthroplasty, Shoulder replacement, Total shoulder arthroplasty

Introduction

Anatomic total shoulder arthroplasty (aTSA) is a common procedure in the United States, with an increasing incidence in both younger and older patients (1). As the incidence increases, the impending burden of revision procedures has become a concern. While results of primary shoulder arthroplasty are often reported, outcomes of revision procedures are less common due to small patient numbers and limited clinical follow-up.

Aseptic glenoid component loosening has been reported to account for 32% of all complications and occurs in 5.3% of all shoulders following aTSA (2, 3). Aseptic glenoid loosening can be associated with contained or uncontained bone defects that may preclude the reimplantation of a glenoid component. In the setting of glenoid bone deficiency and a functional rotator cuff, removal of the loose glenoid component, conversion to hemiarthroplasty (HA), and concomitant

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glenoid bone grafting has historically been a common treatment strategy (4–7). Recently, failed aTSA has more commonly been converted to a reverse arthroplasty given the improved glenoid fixation and the successful reported results (8–10). Certainly, revision to reverse arthroplasty carries higher implant cost and risk for surgical complications. The purpose of this study was to evaluate results of revision of aTSA to a HA in patients with aseptic glenoid loosening and an intact rotator cuff.

Materials and Methods

This study was conducted after approval by the Institutional Review Board. We identi-fied patients who underwent revision shoulder arthroplasty at a single tertiary care health system from 2000 to 2015. Cases were identified by common procedural (CPT) codes 23470 (hemiar-throplasty), 23472 (total shoulder arthroplasty), 23473 (revision of total shoulder arthroplasty, humeral or glenoid component), and 23474 (revision of total shoulder arthroplasty, humeral or glenoid component). Patients who were revised to hemiarthroplasty from aTSA were identified by retrospective chart review. Exclusion criteria included patients who underwent placement of a hemiarthroplasty antibiotic spacer for infection, those who underwent revision for etiologies other than aseptic glenoid component loosening, those who underwent arthroscopic glenoid component removal, those with irreparable rotator cuff tears, and those without two years of follow-up.

Preoperative variables were collected by retrospective chart review. Variables included age, sex, Charlson comorbidity index score, dominant-sided surgery, and the diagnosis leading to the index aTSA (11). Operative notes were reviewed to classify glenoid bone loss, concomitant procedures (including glenoid bone grafting, humeral head exchange and stem revisions), rotator cuff status, and intraoperative complications. The extent of glenoid bone loss was graded based on location of deficiency (peripheral, central, or combined) and severity (mild, moderate, severe) as described by Antuna et al (4).

To determine implant survival and postoperative complications, we conducted a retro-spective chart review and contacted patients as needed at a minimum of 2 years from revision surgery. We obtained patient-report outcome measures for patients with surviving implants. These included the American Shoulder and Elbow Surgeons Score (ASES), Single Assessment Numerical Evaluation (SANE), Visual Analog Scale for pain (VAS; 10 point scale), the Short Form-12 Health Survey (SF-12), and patient satisfaction (on scale of 1-5; 1 being very dissatis-fied and 5 being very satisfied) were obtained (12–15).

Statistical Methods

Patient-reported outcomes after hemiarthroplasty were analyzed for measures of central tendency and variation. The Kaplan-Meier method was used to summarize implant survival following hemiarthroplasty as a function of time elapsed from surgery.

Results

There were 618 patients who underwent revision shoulder arthroplasty at our institution during the study period and 32 patients who underwent glenoid component removal following aTSA. After applying inclusion and exclusion criteria, the authors retrospectively reviewed medical records of 17 patients (3% of all revision arthroplasties at our institution during the study period). The mean patient age at index TSA was 56±7 years (range 41-71 years). There were 7 women and 10 men, and 12 patients underwent dominant-sided surgery. Mean Charlson Comor-bidity Index was 3.8±2.4 (range 0-10). Five patients underwent shoulder surgery prior to index aTSA and two patients underwent multiple (2) prior surgeries. Indications for the primary aTSA included osteoarthritis (15), posttraumatic arthritis (1) and avascular necrosis (1) [Table 1]. The indication for revision was painful glenoid component loosening in all patients. Three patients also had a diagnosis of concurrent humeral loosening and two patients had a diagnosis of hu-meral stem malposition. Preoperative functional scores and advanced imaging were scarcely available, and were therefore excluded from our data.

Operative Findings and Techniques

The characteristics of the study group at time of revision are shown in Table 2.

Glenoid bone deficiency could be classified based on operative reports in 15 patients. Cases were classified as severe central (11), severe combined (2), severe peripheral (1) and mod-erate central (1). Sixteen shoulders underwent glenoid bone graft with cancellous allograft (15) or iliac crest autograft (1). Two patients underwent impaction grafting of the humerus using cancel-lous allograft. Three patients had partial-thickness subscapularis tears, one patient had a full-thickness subscapularis tear, and one patient had a full-thickness supraspinatus tear. The humeral stem was revised in 5 patients due to loosening (3) or malpositioning (2). Humeral head compo-nent exchange was performed in all patients.

There was no clinical suspicion for infection in any patient at revision surgery. Routine cultures showed bacterial growth in 4 patients [coagulase-negative Staphylococcus species (2), Propionibacterium acnes (1) and Staphylococcus aureus (1)). All were treated with appropriate antibiotic courses.

Survival, Complications and Reoperation

Implant survival rate was estimated to be 88% (15 of 17) at 2 years and 67% (8 of 12) at 5 years by Kaplan-Meier analysis. There were no intraoperative complications and 6 (35%) post-operative complications following revision to HA. These included symptomatic gle-noid-sided arthrosis (5) and humeral component loosening (1).

One patient with symptomatic glenoid arthrosis did not undergo reoperation during the study period. At time of survey, this patient had an ASES and pain scores of 40 and 7, respec-tively, and was awaiting reoperation. The remaining four patients with symptomatic glenoid ar-throsis underwent glenoid reimplantation at a mean of

Table 1. Patient Characteristics at time of index aTSA

Patient	Age at aTSA / Sex	Dominant-sided surgery	BMI	Charlson Comorbidity Index (age-adjusted)	Surgeries prior to aTSA	Indication for aTSA
1	41 / M	Yes	23.73	1	Labral repair, Interposition arthroplasty	PTA
2	56 / F	Yes	.	5	0	AVN
3	59 / F	Yes	45.2	6	0	OA
4	67 / F	No	18.3	3	Arthroscopic capsular release	OA
5	59 / F	Yes	28.32	6	0	OA
6	71 / F	No	30	7	0	OA
7	58 / F	Yes	26.5	4	0	OA
8	61 / M	Yes	29.83	2	0	OA
9	42 / M	Yes	.	0	0	OA
10	51 / M	Yes	30.22	5	0	OA
11	54 / M	No	38.5	1	Arthroscopic debridement	OA
12	60 / M	No	32.28	4	0	OA
13	54 / M	Yes	22.24	3	0	OA
14	59 / M	Yes	30.85	3	0	OA
15	51 / M	No	27.89	2	Labral repair, RCR	OA
16	58 / M	Yes	24.36	3	Acromioplasty	OA
17	57 / F	Yes		10	0	OA

PTA = post-traumatic arthritis, AVN = avascular necrosis of humeral head, OA = osteoarthritis, RCR = rotator cuff repair

Table 2. Characteristics at Revision to HA

Pt	Time to HA (y)	Age	Indication	Extent of Glenoid Bone loss	Rotator Cuff Tear	Type of Graft	Humeral Revision
1	10.7	52	GL	Severe-Combined		CA	No
2	6.8	62	GL+HL	Severe-Central		CA	Yes - loosening
3	7.8	67	GL+HL	Severe-Central		CA	Yes - loosening
4	10.2	78	GL	Severe-Central		CA	No
5	6.8	66	GL	Severe-Central		CA	No
6	0.6	71	GL	Moderate-Central	Subscapularis, PT	CA	Yes - malpositioning
7	12.2	71	GL	Severe-Peripheral	Subscularis, full-thickness	CA	No
8	0.7	62	GL	Severe-Central	Posterosuperior, FT	CA	No
9	2.1	44	GL	Severe-Central		CA	No
10	20.1	71	GL+HL	Severe-Central	Subscapularis, PT	CA	Yes - loosening
11	0.9	55	GL	Severe-Central	Subscapularis, PT	CA	Yes - malpositioning
12	14.0	74	GL	Severe-Central		CA	No
13	10.2	64	GL	Severe-Combined		CA	No
14	5.0	64	GL	(OSH)		Iliac crest	No
15	8.5	60	GL	Severe-Central		CA	No
16	10.8	68	GL	Severe-Central		CA	No
17	1.0	58	GL	(OSH)		N/A	No

Y= Yes; N= No; CA = cancellous allograft; SS = subscapularis; PS = posterosuperior rotator cuff; PT = partial thickness; FT = full thickness

Table 3. Outcomes in Implant Survival

Pt	Follow-up (m)	ASES	SANE	VAS Pain	SF-12 M	SF-12 P	PS	Complications
1	30	40	60	7	18	36	4	Glenoid arthrosis
2	88	70	60	3	55	45	4	
3	71	28	35	7	44	21	1	
4	(unable to communicate)							
5	46	77	40	1	65	31	4	
6	85	43	90	7	39	33	4	
7	56	57	68	2	46	36	3	
8	59	27	25	6	64	41	1	
9	100	68	30	1	29	57	3	
10	80	98	98	0	63	48	5	
11	89	72	37	1	35	33	3	
12	(deceased)							

40 months (range, 9-63) following hemiar-throplasty. One patient also underwent stem revision due to component malpositioning. None of these patients with a complication were noted to have rotator cuff pathology, clinical signs of instability or positive intraoperative cultures at time of revision to HA. Two patients required repeat glenoid bone grafting at the time of reoperation. At time of survey, three patients had surviving reimplanted glenoids, however one did require reoperation for lesser tuberosity (LT) non-union at 4 months following the second revision. Mean ASES and pain scores in these three patients were 79 (range, 70-90) and 3.3 (range 1-7); two were very satisfied with their outcome and the third was satisfied.

The patient with humeral component loosening underwent stem revision and glenoid reim-plantation at 8 months following HA. This patient was deceased at time of survey follow-up.

Outcomes in Implant Survival Group

Functional outcomes scores were collected from 10 of 12 patients (83%) with surviving implants at a mean follow-up of 70±21 months from HA (range 30-100). Two patients were deceased and one patient was could not communicate due to other medical conditions. Mean ASES score for surviving implants was 58±22 (range 27-98). Mean SANE score was 54±24 (range 25-98), and mean VAS pain score was 3.5±2.8 (range 0-7). Mean SF-12 Mental and Physical components were 46±15 (range 18-65) and 38±10 (range 21-57), respectively. Five patients reported being either satisfied or very satisfied, 3 patients were neutral and 2 patients were very dissatisfied with the status of their shoulder [Table 3].

Discussion

Aseptic glenoid loosening and failure of aTSA can result in deficient glenoid bone stock that is not amenable to glenoid component reimplantation. In comparison to arthroplasties of other joints, the small anatomic size of the glenoid can create a challenging reconstructive problem. Reverse arthroplasty has gained popularity in revision cases with poor glenoid bone stock due to the improved baseplate fixation and more reliable graft healing (6, 8, 16). However, there may still be clinical situations such as patients of young age, well-preserved preoperative range of mo-tion, and a healthy rotator cuff that may be better served with revision to HA.

In this study, patients typically had severe glenoid defects and underwent component removal and bone grafting with variable techniques. Outcomes in cases of implant survival varied, but were reasonably successful at a mean 5.8-years follow-up. Previous studies on outcomes of conversion of failed aTSA to HA have found wide ranges of functional scores but a signifi-cant number of patients with a good result [Table 4]. Deutsch et al recorded ASES and 10-point pain scores and found mean values of 52 (range 22-91) and 3.5 (range 1.3-5.0), respectively, at 4-year follow-up. Based on the literature, it appears that reimplantation of a glenoid component in cases of aseptic loosening leads to better pain relief and satisfaction; however, conversion to HA can also lead to reasonable results (4, 17, 18).

Despite the successful results that can be achieved with conversion of aTSA to HA, there is risk of both complications and reoperation. Five of 17 patients (29%) required glenoid reimplantation following revision to HA, and all within approximately 5 years of HA. Previous studies have also reported high reoperation rates, ranging from 11-28%, and most commonly involv-ing glenoid reinsertion [Table 4] (4, 7, 17). While reverse arthroplasty may eliminate the need for revision due to symptomatic glenoid arthrosis, younger patients with healthy rotator cuff status may be better served by treatment of aseptic glenoid loosening with conversion to HA. If glenoid arthrosis results in persistent symptoms, a glenoid component can be placed at a later date with

Table 4. Results from previous studies examining outcomes of HA following aTSA

Article	n	Follow-up	AFE	AER	Outcomes	Reoperation rate	Comparison to aTSA → aTSA
Antuna et al, 2001 (2) 2 to 12 years	18	59 months (24-144)	112	40	Pain (out of 5) decreased from 4.2 to 2.4. 7 unsatisfactory results[x].	3 patients (28%) underwent glenoid reinsertion at mean of 20 months.	Patients with glenoid revision were significantly more satisfied and experienced greater improvements in external rotation.
Dines et al, 2006 (8)	12 (7 w/o bone graft)	76 months (24-168)	-	-	Mean UCLA Score = 27. Mean L'Insalata Score = 76. Excellent result in 7 shoulders, good in 2, fair in 3[x].	None.	No significant differences. (Mean UCLA = 25.25; Mean L'Insalata = 78.0)
Phipantakul et al, 2006 (17)	20	34 months (24-36)	115	33	Satisfactory pain relief in 22 of 24 shoulders (including TSA).	4 patients (20%) underwent glenoid reinsertion at mean of 11 months	n=4. Did not separate outcomes of 4 patients undergoing glenoid reimplantation.
Neyton et al, 2006 (14) central, and cavitary, and one had an additional peripheral component. Patients were evaluated with a subjective assessment, Constant score, and radiographs at a mean follow-up of 30 months (range, 24-39 months	9	30 months (24-39)	114 (30-140)**	30 (10-70) **	Mean Constant score from 46 to 50. Pain from 4 to 7.8. 5 patients with satisfactory results[x].	1 patient (11%) underwent RSA at 36 months due to massive RCT.	-
Deutsch et al, 2007 (7)	13	4 years (2-8)	117 (60-160)	39 (10-55)	Mean ASES = 52 (22-91). Mean Pain= 3.5. (1.3-5.0). 7 of 13 patients reported status of their shoulder as "better" or "much better."	2 patients (15%) underwent glenoid reinsertion at 13 and 16 months.	n=30. Greater improvements in pain and external rotation. Also trend towards better pain relief.
Elhassan et al, 2008 (9)	5	45 months (25-92)	112	32	Mean Constant score = 75 (47-92).	1 patient (20%) underwent RSA at 13 months due to massive RCT.	Only 3 patients. No significant differences. Mean Constant Score from 32.3 to 68.6, but greater gains in forward elevation. 1 patient required reoperation for infection.
Cheung et al, 2008 (6)	35	6.2 years (0.8-26.2)	96	42	Mean pain score from 4.3 to 3. Unsatisfactory result in 32 patients (16 due to immobility, 16 due to persistent pain)[x].	7 patients (20%) required reoperation. 6 patients underwent glenoid reinsertion at mean of 3.5 years. 1 patient underwent resection at 11 months.	7 of 33 (21%) shoulders required reoperation at mean of 7 years (1-12). No significant differences in survival, ROM or pain. Trend towards better satisfaction and more excellent/satisfactory results by modified Neer rating.
Scalise and Ianotti, 2008 (18)	11	38 months (24-73)	-	-	Penn Pain from 10 to 17. Penn Satisfaction from 2 to 7. Penn function from 11 to 33. Overall Penn Shoulder Score from 23 (10-36) to 57 (21-94).	None.	-
Current Study, 2017	17	83 months (30-213)	-	-	Implant survival in 12 patients. Mean ASES = 59 (range 20-98). Mean Pain= 3.5 (0-7).	5 patients (29%) required glenoid reinsertion at mean 34 months (range 8-63).	-

Ranges are included if provided in study. "*" = results include 4 patients who underwent glenoid replacement at primary revision. "**" = decreased from pre-operative mean AFE of 119 and AER of 46. "[x]" = based on modified Neer result criteria.

reasonable results (19).

As RSA utilization continues to increase, its indications have expanded to include revi-sion shoulder arthroplasty with glenoid bone loss. Recent studies have examined the outcomes of RSA in patients similar to the ones presented in our study. Melis retrospectively analyzed outcomes in a group of 37 patients with failed aTSA due to glenoid loosening at a mean follow-up of 47 months (20). All patients were reported to have glenoid bone loss of unspecified severity with 29 (78%) requiring bone grafting. Different from our study, 65% had rotator cuff tears at time of RSA. The mean Constant score improved from 24 to 55, and the overall complication and reoperation rates were 30% and 22%. Walker et al. reported on a cohort of 22 patients at a minimum 2 year follow-up who underwent revision of a failed aTSA to an RSA (10). Sixteen patients had deficient glenoid bone stock, 7 of which were rated as severe by the Antuna classification (4). The mean ASES score was 68 (range 38-97) and the complication rate was 23%. It is unclear whether patients in our study would have had better results with conversion to RSA instead of HA; however, the literature with indicate a similarly diverse complication rate.

This study has multiple limitations, many of which stem from its retrospective nature. The small sample size and diverse demographics precludes the ability to statistically identify factors that may determine differences in clinical outcomes. This is in large part due to the rarity of this procedure, even at a high-volume institution. Preoperative scores were not available for patients and range of motion and radiographic data was not consistently recorded either preoperatively or postoperatively to allow for useful analysis. We attempted to analyze radiographs from final clinical follow-up for graft subsidence and medial erosion. However, this data was available for only 8 patients and only 2 had images from the minimum 2-year follow-up used for this study.

HA for failure of aTSA due to aseptic glenoid loosening is associated with modest survival rates and clinical results. There exists a high risk of reoperation, particularly due to persistent glenoid-sided pain. As indications for reverse arthroplasty continue to expand, it is important to view the results of revision of a failed aTSA to a reverse arthroplasty within the context of the result of alternative procedures, such as the option discussed in this study.

Conflicts of interest: On behalf of all authors, the corresponding author states that there is no conflict of interest.

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