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Reverse Shoulder Arthroplasty for Patients with Massive Rotator Cuff Tears or Cuff Tear Arthropathies at a Minimum Follow-up of 7 Years

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Abstract

Purpose: To evaluate indications and factors that influence long-term clinical outcomes and revision rates for reverse shoulder arthroplasty (RSA) in shoulders with irreparable massive rotator cuff tears (mRCTs) or cuff tear arthropathies (CTAs).
Methods: The authors retrospectively evaluated a consecutive series of shoulders with no fracture sequelae that underwent primary RSA between 2011 and 2013. Independent observers collected demographic data, surgical techniques, and implant types, as well as primary outcome measures such as American Shoulder and Elbow Society (ASES) score and Constant score (CS).
Study design: Case series, level IV.
Results: From the initial series of 123 patients that underwent RSA, 29 patients died (24%) for reasons unrelated to the shoulder arthroplasty, 11 were lost to follow-up (9%), and 4 required revision surgery (3%). The final cohort of 79 patients comprised 55 women (70%), and 24 men (30%), aged 72.7 ± 7.0. At a final follow-up of 8.9 ± 0.6 years (range: 7.4-10.3) the absolute CS was 59.0 ± 16.2, the age-/sex-adjusted CS was 76.6 ± 41.2, and ASES was 77.1 ± 20.3. Univariable analysis revealed no associations for absolute CS, but revealed that age-/sex-adjusted CS was significantly lower for patients with high blood pressure ($\beta = -15.8$, $p = .025$).
Conclusions: At a minimum follow-up of 7.4 years, the absolute CS was 59.0 ± 16.2, the age-/sex-adjusted CS was 87.4 ± 24.1 and ASES was 77.1 ± 20.3. When stratifying the outcomes of RSA by indication, there were no significant differences in patients with mRCTs versus CTA in terms of absolute CS, age-/sex-adjusted CS, and ASES. Univariable analysis revealed no association with absolute and age-/sex-adjusted CS for type of indication or surgical approach.

Keywords

reverse shoulder arthroplasty, massive rotator cuff tears, cuff tear arthropathy, long term

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Introduction

Reverse shoulder arthroplasty (RSA) is the most common form of shoulder arthroplasty, and over recent years, its use for shoulder arthroplasty doubled from 27% in 2005 to 52% in 2015, as it can be used for a number of different indications.[1]

The most common indications for primary RSA are degenerative indications such as osteoarthritis (OA) (45%) and rotator cuff arthropathy (35%).[2] A recent systematic review found lower clinical outcomes for patients that underwent RSA for rotator cuff tears compared to cuff tear arthropathy (CTA) or primary OA.[3] The majority of studies included in that systematic review were short- to midterm, and only 1 study on long-term outcomes was included,[4] which found that RSA remained an effective treatment option with long-term implant survival rates similar to those described in previous publications,[5–7] but that outcomes may be influenced by both the indications and time since implantation.

Knowledge about outcomes of RSA stratified by different indications can assist clinicians in setting realistic expectations and goals for recovery given the expanding indications and utilization of RSA. The purpose of this study was to evaluate indications and factors that influence long-term clinical outcomes and revision rates of RSA in shoulders with irreparable massive rotator cuff tears (mRCTs) or CTAs. The hypothesis was that there would be no significant differences between patients with mRCTs versus CTA in terms of clinical scores.

Materials and Methods

Study Design

The authors retrospectively evaluated a consecutive series of patients that underwent primary RSA (Humelock Reversed, Fx Solutions) in shoulders with mRCTs or CTA and no fracture sequelae between December 2011 and December 2013 by 6 senior surgeons (experience, 7-17 years) (Table 1). All patients provided informed consent for the use of their data and images for research and publishing purposes.

Clinical Assessment

Independent observers collected demographic data, clinical scores such as American Shoulder and Elbow Society (ASES) score, absolute (raw) Constant score (CS), age-/sex-adjusted CS according to Constant et al.,[8] as well as intraoperative data including sur-

Table 1. Characteristics of the Initial and Final Cohorts.

	Initial cohort (n = 123)		Final cohort (n = 79)	
	Mean ± SD n %	Range	Mean ± SD n %	Range
Age at index surgery (years)	73.9 ± 7.1	(52–95)	72.7 ± 7.0	(52–86)
BMI	27.5 ± 3.7	(20.2–39.4)	27.7 ± 3.9	(20.2–39.4)
Sex				
Male	43 (35%)		24 (20%)	
Female	80 (65%)		55 (45%)	
Side				
Right	72 (59%)		46 (37%)	
Left	51 (41%)		33 (27%)	
Comorbidities				
Hypertension	41 (33%)		24 (20%)	
Cardiovascular	25 (20%)		11 (9%)	
Overweight	82 (67%)		51 (41%)	
Dyslipidemia	15 (12%)		10 (8%)	
Osteoporosis	7 (6%)		5 (4%)	
Thromboembolic	15 (12%)		12 (10%)	
Diabetes	14 (11%)		9 (7%)	
Indication				
Cuff tear arthropathy (CTA)	94 (76%)		58 (47%)	
Massive rotator cuff tear (mRCT)	29 (24%)		21 (17%)	
Approach				
Superolateral	88 (72%)		58 (47%)	
Deltopectoral	35 (28%)		21 (17%)	
Distal locking screws				
No	114 (93%)		75 (61%)	
Yes, 1 screw	5 (4%)		2 (2%)	
Yes, 2 screws	4 (3%)		2 (2%)	

Abbreviations: BMI, body mass index; RSA, reverse shoulder arthroplasty; SD, standard deviation.

gical techniques, and implant types. Following surgery, all complications, reoperations, and revisions were noted. At a minimum follow-up of 7 years, independent observers collected the ASES score, CS, and pain on visual analogue scale (VAS).

Surgical Technique

All surgeries were performed in the beach chair position under general anesthesia and interscalene block. Four surgeons used exclusively the deltopectoral approach, except in 1 patient who had a previous superolateral incision, while 2 surgeons used exclusively the superolateral approach. The subscapularis was preserved when the superolateral approach was used, and reinserted when the deltopectoral approach was used. All patients were implanted with the cementless Humelock Reversed stem (FX Solutions). The glenoid was exposed, and the baseplate was fixed to the reamed articular surface with a 10° inferior tilt using 4 locking screws. The glenosphere was attached to the baseplate either with a peripheral taper and 1 central screw. The humeral stem was inserted into the prepared humeral canal with an aimed retroversion of 20°, and distal interlocking screws were used when adequate fixation could not be obtained. The humeral cup was attached to the stem, and the shoulder was reduced (Figure 1).

Postoperative Rehabilitation

Patients were immobilized during the night, and used a sling during the day for the first 4 weeks. Gentle passive range of motion (ROM) and pendulum exercises were allowed immediately following surgery under the supervision of a physiotherapist. Active ROM exercises were allowed 6 weeks following surgery.

Informed Consent

This study was performed in accordance with the ethical standards of the 1964 Declaration of Helsinki, and approved by the institutional review board (COS-RGDS-2022-02-005-

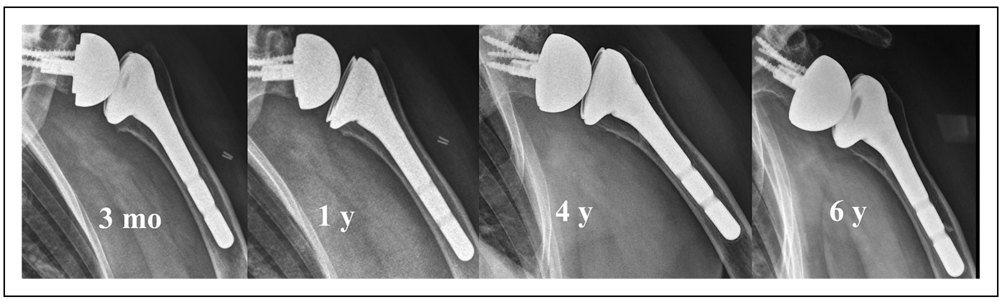

Figure 1. Sequence of radiographs showing final implant positioning.

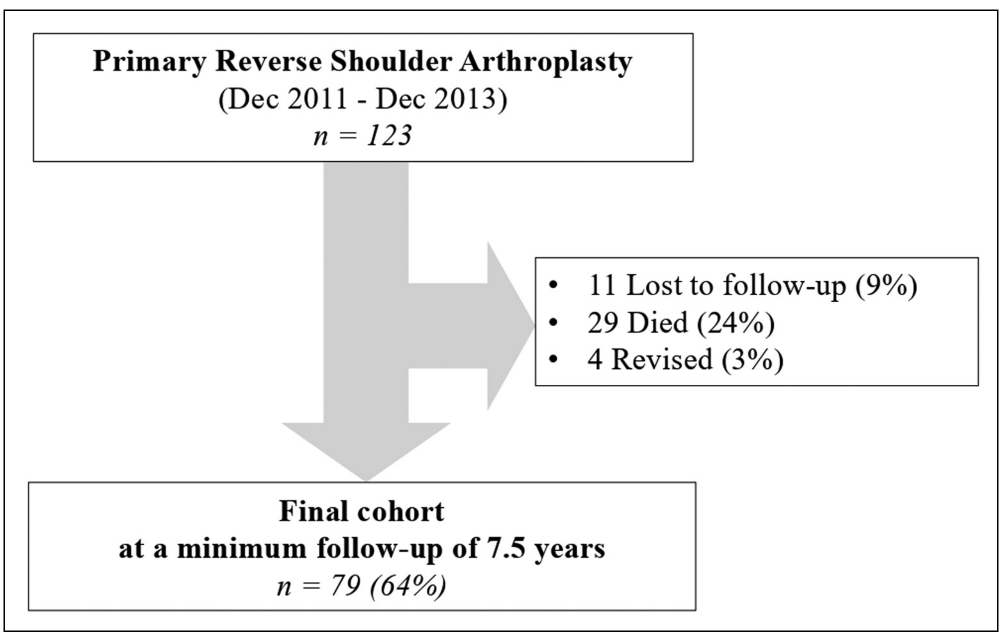

Figure 2. Study flowchart.

NOURISSAT-G). All participants provided informed consent for the use of their data.

Statistical Analysis

Descriptive statistics were used to summarize the data. The Shapiro–Wilk test was used to verify the normality of distributions. Continuous data were compared using Wilcoxon rank-sum tests or Mann—Whitney tests and categorical variables were compared using chi-square tests. *P* values <.05 were considered significant. Statistical analyses were performed using R version 4.1.1 (R Foundation for Statistical Computing).

Table 2. Pre- and Postoperative Functional Outcomes.

	RSA (n = 79)	
	Humelock Reversed	
	Mean ± SD	Range
Follow-up (years)	8.9 ± 0.6	(7.4–10.3)
Absolute CS (0–100)		
Preoperative	20.3 ± 6.8	(6.0–39.0)
Postoperative	59.0 ± 16.2	(12.0–90.0)
Net change	44.4 ± 19.5	(1.0–80.0)
Age-/sex-adjusted CS		
Preoperative	28.3 ± 9.3	(9–52)
Postoperative	87.4 ± 24.1	(19–125)
Net change	59.1 ± 25.8	(−6-99)
ASES score (0–100)		
Preoperative	22.1 ± 9.6	(9–54)
Postoperative	77.1 ± 20.3	(13–100)
Net change	54.6 ± 24.1	(0–87)

Abbreviations: ASES, American Shoulder and Elbow Surgeons; CS, Constant score; RSA, reverse shoulder arthroplasty; SD, standard deviation.

Results

From the initial series of 123 patients that underwent RSA (Table 1), 29 patients died (24%) for reasons unrelated to their shoulder arthroplasty, 11 were lost to follow-up (9%), and 4 required revision surgery (3%); 1 due to infection (both glenoid and humeral component exchange), 1 due to infection and subsequent dislocation (both glenoid and humeral component exchange), and 2 due to dislocation (only glenoid component exchange) (Figure 2). This left a final cohort of 79 patients, aged 72.7 ± 7.0 (range: 52-86) at index surgery, was evaluated at a mean follow-up of 8.9 ± 0.6 years (range: 7.4-10.3). The final cohort comprised 55 women (70%) and 24 men (30%). Their absolute CS was 59.0 ± 16.2 (range: 12-90), the age-/sex-adjusted CS was 87.4 ± 24.1 (range: 19-125) and ASES was 77.1 ± 20.3 (range: 13-100) (Table 2). Further investigation of patients with postoperative CS ≤30 revealed the following explanations:

- A 76-year-old woman with CS of 12 points due to unexplained chronic pain despite several consultations and treatments by different specialists.
- A 79-year-old woman with CS of 13 points who lived alone in a remote rural area since index surgery and could not attend a rehabilitation program.
- A 72-year-old woman with CS of 27 points who had a shoulder dislocation 9 years following index surgery (3 days before last follow-up visit).
- A 75-year-old woman with CS of 29 points who was diagnosed with amyotrophic lateral sclerosis (ALS) 8 years following index surgery.
- A 63-year-old man with CS of 30 points who suffered a traumatic acromial fracture that could not be managed surgically 18 months following index surgery.

Table 3. Pre- and Postoperative Functional Outcomes Stratified by Indication.

	CTA (n = 58)		mRCT (n = 21)		
	Mean ± SD	Range	Mean ± SD	Range	*P* value
Follow-up (years)	8.9 ± 0.6	(7.4–10.34)	8.8 ± 0.5	(8.1–10)	*.410*
Absolute CS (0–100)					
Preoperative	20.0 ± 6.7	(6–34)	21.0 ± 7.0	(9–39)	*.690*
Postoperative	59.2 ± 14.1	(12–79)	58.5 ± 21.1	(13–39)	*.840*
Net change	44.5 ± 17.6	(1–78)	44.0 ± 24.0	(2–39)	*.760*
Age-/sex-adjusted CS					
Preoperative	28.1 ± 9.3	(9–49)	28.8 ± 9.7	(11–39)	*.850*
Postoperative	87.9 ± 21.0	(19–125)	86.2 ± 31.0	(20–39)	*.720*
Net change	59.7 ± 23.0	(6–99)	57.8 ± 31.6	(1–39)	*.820*
ASES score (0–100)					
Preoperative	21.3 ± 8.1	(9–47)	24.8 ± 13.7	(10–39)	*.780*
Postoperative	77.5 ± 19.9	(15–100)	76.0 ± 21.9	(13–39)	*.880*
Net change	56.9 ± 23.3	(0–87)	47.4 ± 26.5	(3–39)	*.240*

Abbreviations: ASES, American Shoulder and Elbow Surgeons; CS, Constant score; CTA, cuff tear arthropathy; RCT, rotator cuff tear; SD, standard deviation.

When stratifying the outcomes of RSA by indication (Table 3), there were no significant differences among patients that had mRCT versus CTA in terms of absolute CS, age-/sex-adjusted CS, or ASES.

Univariable analysis revealed that absolute CS was not associated with any preoperative or intraoperative factors (Table 4), but that age-/sex-adjusted CS was significantly lower for patients with chronic hypertension ($\beta = -15.8$, $P = .025$) (Table 5).

Discussion

The most important findings of this study were that, at a minimum follow-up of 7.4 years, the absolute CS was 59.0 ± 16.2 (range: 12-90), the age-/sex-adjusted CS was 87.4 ± 24.1 (range: 19-125) and ASES was 77.1 ± 20.3 (range: 13-100). When stratifying the outcomes of RSA by indication, there were no significant differences between patients with mRCTs versus CTA in terms of absolute CS, age-/sex-adjusted CS, and ASES. Finally, univariable analysis revealed no associations between either absolute or age-/sex-adjusted CS with indication or surgical approach. These findings confirm the hypothesis that there was no significant difference between patients with mRCTs versus CTA in terms of clinical scores.

There is still limited information on the indications and factors, such as fatty infiltration, scapular notching, and surgical approaches. that are associated with poor clinical outcomes following RSA. A study by Hartzler et al.[9] found poor early functional outcomes of RSA for the treatment of mRCTs,[9] which could be due to the degeneration of the rotator cuff muscles that could lead to greater mechanical stress on the deltoid muscle, resulting in faster degradation of its function.[4] Furthermore, there is conflicting evidence in the literature on factors that affect outcomes of RSA such as age, sex, and BMI.[10,11] Favard et al.[6] found that older patients scored worse in absolute CS compared to their younger counterparts. The reasons are not yet fully understood, but are likely to be associated with the strength and ROM subcomponents of the CS, suggesting a possible impairment of active deltoid power. Experimental studies have shown that the aging of muscle tissue decreases its adaptation to repetitive contraction-stretching movements and may lead to a decrease in performance.[12,13] In the present study, no associations were found between age and either absolute or age-/sex-adjusted CS. Furthermore, prior ipsilateral shoulder surgery has been found to be a poor prognostic indicator after RSA,[14] although some studies have demonstrated no significant difference in RSA outcomes despite prior surgery.[15] Treatment of the dominant arm has also been suggested to yield better functional outcomes after RSA, although clinical outcome scores were not affected by arm dominance.[16]

In the present study, 4 of the 123 patients required a revision (3%); 4 required revision surgery (3%); 1 due to infection (both glenoid and humeral component exchange), 1 due to infection and subsequent dislocation (both glenoid and humeral component exchange), and 2 due to dislocation (only glenoid component exchange). In addition to this, 1 patient had a dislocation following the index procedure, but did not require implant exchange, and was treated conservatively. The revision rate of 4% in the present study is lower

Table 4. Univariable Regression Analysis of Postoperative Absolute CS.

Variable	β	95% CI	P value
Age at index operation (yrs)	−.5	(−1.2-0.1)	.091
BMI	−.1	(−1.2-1.0)	.843
Male sex	8.1	(−0.4-16.5)	.061
Indication			
Cuff tear arthropathy (CTA)	.7	(−8.1-9.5)	.877
Massive rotator cuff tear (mRCT)	REF		
Surgical approach			
Superolateral	REF		
Deltopectoral	−5.7	(−14.3-2.8)	.187
Comorbidities			
Hypertension	−5.8	(−21.4-0.8)	.181
Cardiovascular	−7.6	(−18.6-3.4)	.172
Overweight	−1.6	(−9.8-6.6)	.693
Dyslipidemia	6.5	(−6.4-19.5)	.316
Osteoporosis	−13.1	(−27.9-1.8)	.083
Thromboembolic	−4.4	(−15.1-6.2)	.410
Diabetes	−9.1	(−22.0-3.7)	.159

Abbreviations: BMI, body mass index; CI confidence interval; CS, Constant score; OA, osteoarthritis; REF, reference; yrs, years.

Table 5. Univariable Regression Analysis of Postoperative Age-/Sex-Adjusted CS.

Variable	β	95% CI	P value
Age at index operation (yrs)	.3	(−0.7-1.3)	.546
BMI	−.1	(−1.8-1.6)	.902
Male sex	1.2	(−12.7-15.1)	.867
Indication			
Cuff tear arthropathy (CTA)	1.7	(−12.4-15.8)	.814
Massive rotator cuff tear (mRCT)	REF		
Surgical approach			
Superolateral	REF		
Deltopectoral	−8.5	(−22.7-−5.7)	.236
Comorbidities			
Hypertension	−15.8	(−29.5-2.1)	.025
Cardiovascular	−11.4	(−28.1-5.3)	.176
Overweight	2.0	(−15.8-11.9)	.778
Dyslipidemia	9.8	(−12.9-32.5)	.390
Osteoporosis	−23.0	(−57.5-11.6)	.188
Thromboembolic	−2.2	(−18.1-13.6)	.778
Diabetes	17.2	(−37.7-3.4)	.099

Abbreviations: BMI, body mass index; CI confidence interval; CS, Constant score; OA, osteoarthritis; REF, reference; yrs, years.

than the rate reported by Bacle et al.,[4] who found a revision rate of 12% in a larger cohort of 186 patients.

The findings of the present study are comparable to other studies on the long-term outcomes of RSA. Favard et al.[6] found a lower postoperative CS of 57 points, while Bacle et al.[4] stratified outcomes based on preoperative indication and found that CTA results in the highest CS with 63 points, while mRCTs result in a CS of 55 points. In the present study, at a minimum follow-up of 7.4 years, the CS for CTA was 59 points, while for RCT it was 59 points, which confirms long-term high clinical outcome scores in association with this etiology. Finally, a systematic review by Kennedy et al.[3] on studies ranging from 22 to 150 months follow-up reported CS of 67 points for CTA and 63 points for mRCT, while a systematic review by Zumstein et al.[17] on studies ranging from 16 to 132 months reported CS of 60 points without stratification by indication. It is worth noting that in the present study, there were 5 patients that had CS $\leq$30 and therefore could be considered as clinical failures, which revealed a total incidence of 9 failures (7.3%; 5 patients with CS $\leq$30 and 4 that required revision) from the initial cohort of 123 patients.

The results of this study should be interpreted with the following limitations in mind. First, as 21% of patients had died before the final assessment, the final cohort comprised 79 patients; this small sample size did not allow for multivariable regression to identify confounding factors. Second, even though the initial cohort consisted of 123 patients, this study might not be adequately powered to draw any definitive conclusions from the comparisons made in terms of surgeon experience, surgical approach, glenoid or humeral component design, or distal interlocking screws. Third, the retrospective data did not include information on previous surgical procedures, or whether the cuff was repaired. Finally, there was no ROM data or pre- or postoperative radiographs to assess implant position, alignment, scapular notching, or stress shielding.

Conclusion

At a minimum follow-up of 7.4 years, the absolute CS was 59.0 ± 16.2 (range: 12-90), the adjusted CS was 87.4 ± 24.1 (range: 19-125) and ASES was 77.1 ± 20.3 (range: 13-100). When stratifying the outcomes of RSA by indication, there were no significant differences in patients with mRCTs versus CTA in terms of absolute CS, age-/sex-adjusted CS, and ASES. Univariable analysis revealed no associations between either absolute or age-/sex-adjusted CS with indication or surgical approach.

Declaration of Conflicting Interests

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