What Are the Instability and Infection Rates After Reverse Shoulder Arthroplasty?

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Abstract

Background A concern regarding reverse shoulder arthroplasty (RSA) is the possibly higher complication rate compared with conventional unconstrained shoulder arthroplasty.

Questions/purposes We determined (1) the rate of instability and infection; (2) whether diagnosis influenced instability and infection rates; and (3) whether these complications affect ASES, Constant, and WOOS scores after RSA.

Methods A prospective database, clinical charts, and radiographs of 284 patients who had undergone primary (n = 212 patients) or revision (n = 72 patients) RSA were reviewed to identify patients whose postoperative course was complicated by instability or infection.

Results The rate of instability was similar in patients with primary (eleven of 212 [5%]) and revision (six of 72 [8%]) reverse arthroplasty. The rate of infection was higher in the revision (five of 72 [7%]) than in the primary (three of 212 [1%]) group. Patients with an irreparable subscapularis tendon had a higher rate of instability (14 of 123 [12%]) compared with patients with a repairable subscapularis tendon (one of 161 [less than 1%]). The fracture sequelae group had the highest rate of instability (seven of 25 [28%]) among diagnoses within the primary group. The rates of infection were similar between the diagnoses within the primary group. The improvements in the ASES score, the Constant score, and the WOOS score from preoperatively to postoperatively were better in the no instability/infection group as compared with the instability/infection group.

Conclusions This information confirms the available literature allowing surgeons to give patients realistic expectations regarding the infection and instability rates after RSA.

Level of Evidence Level III, therapeutic study. See Guidelines for Authors for a complete description of levels of evidence.

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Introduction

Reverse shoulder arthroplasty (RSA) was initially introduced in the 1970s to treat cuff tear arthropathy [1]. These initial RSA designs had a laterally offset center of glenohumeral rotation that led to a high rate (26%) of glenoid component loosening and failure [1]. In the early 1980s, Paul Grammont introduced a novel RSA designed with a "glenosphere" that medialized the center of rotation to within the bone of the glenoid and the era of modern RSA was born [8].

Since its approval in the United States in 2004, the use of RSA has become increasingly common in North America [5]. This increase in use has been accompanied by concern regarding the fact that the complication rate of RSA is higher than that of conventional unconstrained

shoulder arthroplasty. Postoperative complications after RSA occur in up to 50% of patients in some series [18]. The two most common and major complications related to RSA are instability and infection [17]. Instability rates from 2% to 31% and infection rates from 1% to 15% have been reported [1, 2, 4, 6, 9, 10, 13–19]. One of the largest series in the literature to date contains 199 patients from two surgeons with an instability rate of 8% and an infection rate of 4% [17].

We evaluated our large prospective database to confirm the rates of instability and infection in RSA reported in other series. We determined (1) the rate of instability and infection; (2) whether diagnosis influenced instability and infection rates; and (3) whether these complications affect survey scores for self-perceived shoulder function after RSA.

Patients and Methods

We queried a prospective database and identified 284 patients who had undergone primary (n = 212 patients) or revision (n = 72 patients) RSA; all were included in this study. There were 108 males (38%) and 176 females (62%). RSA was performed on the dominant extremity in 168 patients (59%). The average age of the patients was 66.0 years (range, 35–93 years) at the time of surgery. After reviewing the database, the patients' radiographs, and their clinical charts (surgical history, comorbidities, etc), these patients undergoing RSA were divided into a primary RSA group and a revision RSA group. The primary RSA group was further subdivided by etiology into 10 diagnostic categories. The diagnostic categories for primary RSA were primary cuff tear arthropathy (119), massive rotator cuff tears with pseudo-paralysis (25), fracture sequelae (25), acute fractures (16), inflammatory arthropathies (ie, rheumatoid arthritis) (five), instability arthropathy (11), postinfectious arthropathy (six), tumor reconstructions (two), glenohumeral arthritis after radiation therapy (one), and primary glenohumeral arthritis (two). The revision RSA cases had all failed prior shoulder arthroplasty (total or hemiarthroplasty) and lacked a functioning rotator cuff. The minimum followup was 12 months postoperatively (average, 24 months; range, 12–48 months). No patients were lost to followup. No patients were recalled specifically for this study; all data were obtained from medical records and radiographs. Our database of clinical and operative data for all patients undergoing arthroplasty was also queried, which was approved by the Institutional Review Board at our institution.

The sample size of 284 patients had 90% power with a Type I error rate ≤ 0.05 to find a difference in preoperative

to postoperative change on the American Shoulder and Elbow Surgeons (ASES) score of 10 points or greater (ie, larger than the reported minimal clinically relevant difference of 9.7 points) on the ASES survey score using the reported population standard deviation for the ASES survey of 17 points. To maintain statistical power, the instability and infection groups were combined into an instability/infection (ie, complications) group to compare with the patients with no instability/infection (ie, no complications).

The Aequalis (Tornier, Edina, MN) RSA system was used in all patients. In all patients, the reverse prosthesis was implanted through the deltopectoral approach, except for two patients, who underwent a superior approach for concomitant repair of a deltoid detachment. The deltopectoral approach was used because of its familiarity, because it affords excellent exposure of the glenoid allowing inferior placement of the glenosphere and because it can be extended into an extensile exposure if required. The coracoacromial ligament and superior 1 cm of the pectoralis major were released and tenodesis or tenotomy of the long head of the biceps tendon was performed in all patients. The subscapularis tendon, if intact at the time of surgery, was transected using a transtendinous tenotomy and was circumferentially released to increase postoperative external rotation and facilitate repair. The status of the subscapularis tendon and whether it was repairable were assessed and recorded at the time of surgery. When repair was possible, a combined transosseous and transtendinous subscapularis repair was completed using a high-tensile strength nonabsorbable number 2 suture. Preparation of the glenoid included reaming an inferior tilt of 10° and a 36-mm glenosphere was used universally. The choice of a 36-mm glenosphere was based on the fact that this size glenosphere fits most patients. Although a 42-mm glenosphere is certainly more stable, its large size precludes its use in many patients. The humeral implant was cemented in 10° of retroversion in all patients. The "correct" version, however, is unknown because the RSA is a nonanatomic implant. Deltoid tension was assessed with the patient under complete neuromuscular paralysis. Humeral component length was increased using incrementally sized polyethylene spacers until axial motion between the glenosphere and the humeral component was less than 2 mm with longitudinal traction. A closed suction drain was placed at the time of wound closure and removed the day after surgery in all cases to minimize hematoma formation. All patients received antibiotic prophylaxis preoperatively and for 24 hours postoperatively.

After reverse shoulder arthroplasty, patients were seen at 1 week, 6 weeks, 3 months, 6 months, and 1 year. Radiographs were performed at every visit including AP in the

plane of the scapula, scapular Y, and axillary views. Clinical parameters assessed were ROM, strength, and rotator cuff testing. All patients wore a neutral rotation brace for 3 to 4 weeks before beginning physical therapy. After this period, the patients participated in aquatic therapy rehabilitation whenever possible to improve shoulder ROM. Therapy was directed to improve elevation, extension, horizontal adduction, external rotation, and then internal rotation in succession. Patients who were unable to participate in aquatic therapy participated in a land-based regimen with the same objectives. After at least 6 weeks of aquatic or other therapy, if acceptable ROM was gained, patients graduated to a self-directed land-based program. Strengthening exercises were not prescribed for any patient.

Instability and infection rates were calculated using information from the database; these rates were substantiated by information in the patients' radiographs and clinical charts. Functional survey scores, including the American Shoulder and Elbow Surgeons' scores [12], Constant and adjusted Constant scores [3], Single Assessment Numerical Evaluation scores [20], and Western Ontario Osteoarthritis of the Shoulder (WOOS) scores [11] were also obtained from the database. One hundred forty-one of the 284 patients (50%) had complete preoperative and postoperative measures, 10 of whom were in the instability and infection group, at an average of 24 months postoperatively (range, 12–48 months). Although the patients are entered into the database prospectively, the completeness of their data relied on patient followup. It is for this reason that only half of the patients had complete data.

Frequencies and means were used to describe patient characteristics, and the characteristics were compared between groups using chi square analyses or t-tests as appropriate to the scale and distribution of the respective variables. Proportions were used to describe infection and instability rates. We evaluated the differences in infection and instability rates between the primary and revision groups using chi square analyses with exact probabilities. The differences in preoperative to postoperative survey scores were compared between patients with and without complications using two-way analysis of variance with repeated measures. There was no evidence of violations of the assumptions of these tests.

Results

The rate of instability was similar (p = 0.388) in patients with primary (11 of 212 [5%]) and revision (six of 72 [8%]) arthroplasty. The rate of infection was higher (p = 0.030) in the revision (five of 72 [7%]) than in the primary (three of 212 [1%]) group. The average age of patients in the instability/infection group was 62.8 ± 11.8 years, which was lower (p = 0.012) than the no instability/infection group (69.1 ± 10.7 years). Age was not related to the rates of either instability (p = 0.116) or infection (p = 0.703). Males compared with females had over twice the rate of instability (9% versus 4%) and infections (4% versus 2%). Surgery in the dominant extremity (n = 168 [59%]) was not a risk factor for instability or infection (p = 0.462). The proportion of patients with recorded medical comorbidities were similar in the instability/infection group and the no instability/ infection group. Of the 20 patients in our series whose postoperative course was complicated by instability or infection, five (25%) patients' postoperative courses were complicated by both. Of these five patients, three went on to resection arthroplasty, one has a dislocated and chronically infected RSA and is considering treatment options, and one has retained the prosthesis but is on chronic suppressive antibiotics (Tables 1, 2, 3, 4).

Patients with subscapularis tendon insufficiency at surgery (irreparable subscapularis tendon) had a higher (p < 0.001) rate of instability (14 of 123 [12%]) compared with patients with a repairable subscapularis tendon (one of 161 [less than 1%]). For the evaluation of the effect of diagnosis within the primary cases group, the following diagnostic groups were excluded because there were too few subjects in those groups (six or less) for meaningful statistical comparisons: inflammatory arthropathies (ie, rheumatoid arthritis), postinfectious arthropathy, tumor reconstructions, glenohumeral arthritis after radiation therapy, and primary glenohumeral arthritis. Only one case of instability occurred in all of these groups. These patients were included in all other aspects of the analysis. Thus, these analyses were conducted using the primary cuff tear arthropathy, massive rotator cuff tears with pseudoparalysis, fracture sequelae, acute fractures, and instability arthropathy diagnostic groups, representing 94% of all cases. The fracture sequelae group had a higher (p < 0.001) rate of instability (seven of 25 [28%]) than the other four groups combined (three of 171 [2%]). The instability arthropathy and massive rotator cuff tears with pseudoparalysis groups had higher (p = 0.015) rates of instability (three of 36 [8%]) relative to the acute fracture and cuff tear arthropathy groups, who had no instability (0%). The rates of infection were similar between the diagnoses within the primary group.

The improvements in the ASES score, the Constant score, and the WOOS score from preoperatively to postoperatively were better in the no instability/infection group as compared with the instability/infection group (Table 5). Age and time to followup (range, 1–5 years) were unrelated (p > 0.05) to any of the survey measures.

Table 1. Primary reverse shoulder arthroplasty complicated by instability

Case number	Age (years)	Gender	Diagnosis	Subscapular	Time to initial dislocation	Treatment	Subsequent dislocation	Treatment	Final outcome
73	60	F	Fracture sequela	N	6 days	Revise with augments	Y	Closed reduce/bracing	Revised for periprosthetic fixation stable
84	67	M	Fracture sequela	N	3 years	Revise with augments	Y	Closed reduce/bracing	Resection for Infection
117	60	F	Fracture sequela	N	1 week	Closed reduce/bracing	Y	Revise with augments	Stable
306	70	F	Instability arthropathy	N	1 month	Closed reduce/bracing	N	N/A	Resection for Infection
367	43	F	Fracture sequela	N	1 week	Closed reduce/bracing	Y	Revise with augments	Stable
413	46	M	MRCT	N	Dynamic instability (voluntarily dislocate and reduce)	Revise with augments	N	N/A	Continued subluxation considering 36 to 42
418	62	M	Fracture sequela	N	1 week	Closed reduce/bracing	N	N/A	Stable
558	48	F	Fracture sequela	N	2 weeks	Closed reduce/bracing	Y	Revise with augments	Stable
601	58	M	Fracture sequela	N	Between 1 and 6 weeks	Closed reduce/bracing	N	N/A	Stable
674	37	M	Tumor reconstruction	N	2 months	Closed reduce/bracing	N	N/A	Continued subluxation considering augments
718	58	M	MRCT	N	6 weeks	Closed reduce/bracing	N	N/A	Stable

F = female; M = male; MRCT = massive rotator cuff tear; N = no; Y = yes; N/A = not available.

Table 2. Primary reverse shoulder arthroplasty complicated by infection

Case number	Age (years)	Gender	Diagnosis	Surgery before reverse shoulder arthroplasty	Time to infection	Explant	Number of I&D	Final outcome
84	67	M	Fracture sequela	Yes	2 months	Yes	5	Resection; no signs of infection
260	79	M	CTA	Yes	4 years	Yes	3	Reimplanted; no signs of infection
306	76	F	Instability arthropathy	No	3 years	Yes	2	Resection; no signs of infection

I&D = irrigation and débridement; M = male; F = female; CTA = cuff tear arthropathy.

Table 3. Revision reverse shoulder arthroplasty complicated by instability

Case number	Age (years)	Gender	Diagnosis	Subscapular	Time to initial dislocation	Treatment	Subsequent dislocation	Treatment	Final outcome
197	73	M	Revision	N	2 weeks	Closed reduce/ bracing	Y	1) Revise; augments 2) Revise; 36 to 42 3) Revise; double stack augments	Dislocated and chronically Infected- Considering Benign Neglect/ Resection/ Hemi/ Custom Implants
213	69	M	Revision	Y	6 weeks	Revise; augments	N	N/A	Stable
519	82	F	Revision	N	2 weeks	Closed reduce/ bracing	N	N/A	Stable
533	73	M	Revision	N	2 weeks	Open reduce/ bracing	Y	Revise; 36 to 42	Stable
693	71	F	Revision	N	2 weeks	Closed reduce/ bracing	Y	Revise; 36 to 42	Resection for Infection
760	59	M	Revision	N	6 weeks	Closed reduce/ bracing	Y	Revise; 36 to 42	Stable

M = male; F = female; N = no; Y = yes; N/A = not available.

Table 4. Revision reverse shoulder arthroplasty complicated by infection

Case number	Age (years)	Gender	Diagnosis	Cleared infection before reverse shoulder arthroplasty	Time to infection	Explant	Number of I&D	Final outcome
197	73	M	Revision	Yes	9 months	No	1	Chronically infected; considering benign neglect/resection/hemi/ custom implants
267	59	F	Revision	No	2 years	Yes	3	Resection; no signs of infection
316	49	M	Revision	Yes	2 weeks	Yes	3	Resection; no signs of infection
693	71	F	Revision	No	6 weeks	Yes	5	Resection; no signs of infection
760	59	M	Revision	Yes	4 months	No	1	Retained implants; chronic suppressive antibiotics

I&D = irrigation and débridement; M = male; F = female.

Discussion

Through the use of a large single-surgeon prospective database we confirmed (1) the rate of instability and infection; (2) whether diagnosis influenced instability and infection rates; and (3) whether these complications affect survey scores for self-perceived shoulder function after RSA.

Table 5. Preoperative and postoperative outcomes scores at an average of 24 months postoperatively (range, 12–48 months) by the presence of instability/infection versus no instability/infection

Outcome	Instability/infection		No instability/infection		p
	Preoperative	Postoperative	Preoperative	Postoperative	
ASES score	55.1	61.0	56.2	75.8	0.011*
ASES pain	6.6	2.2	6.5	1.4	0.509
Constant total	13.9	42.2	15.0	59.1	0.017*
Adjusted Constant	17.9	56.2	20.4	82.3	0.012*
Constant pain	3.6	8.4	3.3	11.1	0.047*
Constant mobility	4.6	18.4	5.2	26.2	0.053
Constant strength	0.8	5.6	0.5	8.4	0.091
WOOS	73.7	48.8	78.4	30.5	0.007*
SANE	30.5	50.6	21.8	61.2	0.138

p value is the test comparing the preoperative to postoperative change between groups; * $p < 0.05$; ASES = American Shoulder and Elbow Surgeons' score; WOOS = Western Ontario Osteoarthritis of the Shoulder score; SANE = Single Assessment Numerical Assessment score.

This study has several limitations. First, although the overall number of patients undergoing RSA was substantial (n = 284), the number of patients affected by instability or infection was relatively low (n = 20), which limits statistical power. Nevertheless, we identified some factors that were related to the occurrence of these complications. Second, functional survey data were only available on 10 patients in the infection/instability group making it difficult to generalize to the RSA population in general, although we did observe large decrements in functional survey scores in that small group that may be indicative of the potential magnitude of effects resulting from complications after RSA.

With an overall infection rate of 3% and an instability rate of 6% we were able to confirm the reported infection and instability rates available in the literature [1, 2, 4, 6, 9, 10, 13–19]. The relevance of these data lies in the fact that this is the largest single-surgeon cohort in the literature to date with over 280 patients (Table 6).

The rate of instability was similar in the primary and revision groups but was affected by the preoperative diagnosis within the primary group. The effect of diagnosis may be partially attributable to the status of the subscapularis tendon at the time of surgery. Edwards et al. have previously reported the risk of dislocation after RSA was nearly twice as high in patients with an irreparable subscapularis tendon compared with those with a repaired subscapularis tendon [5]. As one would expect, because this report is an analysis of the same cohort, an irreparable subscapularis tendon at the time of surgery led to a significantly higher rate of instability in this series. In only one of the 17 cases of instability was the subscapularis tendon able to be repaired. The fracture sequelae diagnostic group had the highest rate of instability followed by the instability arthropathy and massive rotator cuff tear with pseudoparalysis diagnostic

Table 6. Infection and instability rates from the literature

Study	Number of patients	Followup (months)	Infection rate	Instability rate
Valenti et al. [16]	39	84	5%	NR
Sirveaux et al. [14]	80	45	1%	5%
Rittmeister et al. [13]	8	54	13%	NR
Boulahia et al. [2]	16	35	NR	6%
De Wilde et al. [4]	13	36	15%	31%
Sirveaux et al. [15]	80	44	1%	9%
Boileau et al. [1]	45	40	4%	NR
Werner et al. [18]	58	38	3%	9%
Frankle et al. [6]	60	33	3%	2%
Guery et al. [9]	66	70	5%	3%
Levy et al. [10]	29	35	3%	14%
Wall et al. [17]	199	24	4%	8%
Wierks et al. [19]	20	9	5%	10%
Trappey et al.	284	24	3%	6%

NR = not reported

groups, whereas the acute fracture and cuff tear arthropathy diagnostic groups had no cases of instability. This is likely the result of the ability to better manage the subscapularis tendon in the patients with cuff tear arthropathy and acute fracture. The subscapularis tendon is usually difficult to manage in patients affected by fracture sequelae because their tuberosities are usually malunited, nonunited, or reabsorbed leading to mechanical impingement as well as subscapularis insufficiency. In addition, patients with fracture sequela have contractures and proximal humeral bone loss further exacerbating their instability. In patients with massive rotator cuff tears with pseudoparalysis and instability arthropathy, the subscapularis tendon is generally involved in the massive rotator cuff tears frequently associated with these conditions [7].

To the best of our knowledge there are no reports in the literature about how instability and infection affect survey scores for self-perceived shoulder function after RSA. It is intuitive, however, to believe patients affected by instability and infection after RSA would have worse survey scores than those without these postoperative complications. In the study group not affected by instability and infection the change in total Constant score from preoperative to postoperative (15 to 60) is similar to that reported in the literature (22 to 59) [17]. Likewise, the group without complications had favorable changes in their ASES scores (56 to 75) compared with the literature (34 to 68) [6]. In our study group affected by instability/infection, their change in total Constant scores (14 to 42) and ASES scores (55 to 61) from preoperative to postoperative were much less favorable when compared with the group without complications or the literature.

With the largest study to date on instability and infection after RSA, we have confirmed the infection and instability rates available in the literature, demonstrated how these complication rates can be affected by preoperative diagnosis, and shown the affects of these complications on survey scores for self-perceived shoulder function. This information allows surgeons to give patients realistic expectations regarding these complications and can be used during preoperative counseling to predict how likely they are to occur given the preoperative diagnosis. Additionally, these data can help manage expectations after these complications with respect to the ultimate outcome after RSA complicated by infection or instability.

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