# Revision for instability following reverse total shoulder arthroplasty: outcomes and risk factors for failure

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**Background:** Revision of unstable reverse shoulder arthroplasty (RSA) is significantly challenging, with recurrence rates ranging from 20% to 40%. The purpose of this study was to identify factors associated with recurrent instability. The factors studied included (1) indication for revision RSA (failed primary RSA vs. failed revision RSA), (2) previous attempt at stabilization, (3) mechanism of instability, (4) clinical history of instability, and (5) surgical technique. Outcomes were reported in patients with 2-year follow-up.
**Methods:** All patients undergoing RSA for instability at our institution were identified. A total of 43 surgical procedures in 36 patients were included. Arthroplasty indication prior to instability (14 failed primary RSAs vs. 22 failed revision RSAs), instances of prior attempts at stabilization (14 patients treated at outside institution), mechanism-of-instability classification, clinical history of instability (17 recurrent and 26 chronic cases), and surgical technique were collected. Stability at final follow-up (minimum, 12 months) and clinical outcomes at 2-year follow-up were assessed.
**Results:** Overall, 32 of 36 patients (89%) required 38 revisions to achieve stability at final follow-up (mean, 53 ± 47 months; range, 12-210 months). On comparison of stability by indication, stability was achieved in 13 of 14 patients (93%) in the failed primary group (mean, 65 ± 59 months; range, 12-210 months) compared with 19 of 22 (86%) in the failed revision group (mean, 45 ± 36 months; range, 12-148 months; $P = .365$). The average number of procedures per patient was 3 (range, 2-10) in the failed primary group vs. 4.5 (range, 3-7) in the failed revision group ($P = .008$). Stability was achieved in 12 of 14 patients (86%) with a history of failed stabilization procedures. The most common mechanism leading to persistent instability was loss of compression. Stability was achieved in 14 of 16 patients treated for recurrent instability compared with 18 of 20 treated for chronically locked dislocation ($P = .813$). Continued instability occurred in 33% of patients who underwent glenoid side–only management, 33% who underwent humeral side–only management, and 10% who underwent bipolar revision tactics. At 2-year follow-up, stability was achieved in 18 of 21 patients, with improvements in the American Shoulder and Elbow Surgeons (ASES) score, forward flexion, abduction, external rotation, and the Simple Shoulder Test score ($P = .016$, $P < .01$, $P = .01$, $P < .01$, and $P = .247$, respectively).
**Conclusion:** Patients who underwent multiple revisions after failed previous arthroplasty will require more surgical attempts to achieve stability compared with patients who underwent a revision after failed primary RSA. Loss of compression was the most common

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This study was determined to be exempt from requiring institutional review board approval.

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mechanism of persistent instability. Stabilization was more reliably achieved in cases of recurrent instability than in cases of chronically locked dislocation. Continued instability was noted in one-third of patients who underwent humeral side–only or glenoid side–only revisions and in 10% of those who underwent bipolar revisions. Patients in whom stabilization was successful had improved clinical outcomes.

**Level of evidence:** Level IV; Case Series; Prognosis Study

The frequency of reverse shoulder arthroplasties (RSAs) performed for various pathologic processes rises annually, and each year, the ratio of RSA to total shoulder arthroplasty procedures continues to expand.[4,23] Overall, the number of patients living with shoulder replacements has risen dramatically since 1995, represented by an increase of over 700% in the United States.[11] This rate of growth is projected to continue at least until 2040.[17] With this remarkable growth of RSA surgical procedures in the United States, the importance of understanding complications associated with these procedures becomes even greater.

In a 15-year time span leading up to 2017, the incidence of revision RSA increased by 392%.[5] A literature review by Zumstein et al[25] reported that up to 20% of RSA patients required revision, with instability and infection comprising the majority of revision cases in their study. Furthermore, Boileau[3] presented the leading causes of revision for RSA at his institution, which included instability (38%), infection (22%), humeral complications (21%), and humeral loosening (10%).

Among the aforementioned complications, instability after RSA has a variable range as reported in the literature. At its worst, instability has been reported in up to 31% of primary RSA cases and can be challenging to manage for even experienced surgeons.[6-8,24] Guarrella et al[14] identified risk factors associated with instability in primary RSA patients, including younger age, medialized components, and skeletal findings such as scapular notching or greater tuberosity resorption. They also reported that 42% of patients experiencing instability required revision to manage this complication. These patients often experienced inferior postoperative functional results.[14]

Chae et al[5] reported on dislocations in RSA cases and proposed a treatment algorithm describing 3 methods for increasing stability and deltoid tension: lateralization or upsizing of the glenosphere, use of more constrained polyethylene inserts, and distalization of the humerus by increasing the polyethylene thickness or adding a metal spacer. Markes et al[21] summarized the literature discussing instability and their treatment methods in revision RSA cases. Their conclusion was that maximizing soft-tissue tension while avoiding impingement would be the best means of achieving stability—evidence supported by Chae et al. Although both articles provided some information regarding the treatment of instability, information regarding its treatment in revision RSA remains sparse.

The purpose of this study was to identify which factors are associated with recurrent instability in a patient population consisting of a significant number of revision RSA patients, including (1) indication for reverse arthroplasty (failed primary RSA vs. failed revision RSA), (2) previous attempt at stabilization, (3) mechanism of instability, (4) recurrent vs. chronically locked dislocation, and (5) surgical technique. We hypothesized that patients with a more complex shoulder history (ie, revision to RSA after failed arthroplasty and/or multiple failed attempts at stabilization) would have lower rates of success in terms of stability and functional outcomes after revision for instability.

## Methods

Patients who underwent revision to RSA between January 1, 2002, and September 30, 2019, were retrospectively identified in the shoulder arthroplasty registry of the senior author (M.A.F.). A total of 647 revision RSA cases were identified and further reviewed to determine the indication for revision surgery. The inclusion criteria were (1) indication of instability for revision surgery and (2) minimum 12 months of clinical follow-up. A total of 52 revisions in 45 patients met the criteria for inclusion in this study (8.1% of all revision procedures). A further 9 patients were excluded because of insufficient follow-up (<12 months, 4 patients died and 5 patients did not respond to any attempts at contact [2 phone calls and return mail]) (Fig. 1). In all cases in which complete implant exchange was appropriate, the aforementioned surgeon performed revision using the preferred device (RSP, RSP Monoblock, or AltiVate Reverse; DJO Surgical, Austin, TX, USA).

Patient records, radiographs, and intraoperative notes were screened for the entire study population. Besides baseline demographic characteristics and patient-reported outcome measures (PROMs), the following variables were evaluated for each studied factor:

1. Indication for RSA, with failed primary RSA in 14 patients (7 with index cuff tear arthropathy, 1 with cuff tear arthropathy and humeral bone loss, 2 with massive rotator cuff tears, 2 with failed rotator cuff repair, 1 with nonunion, and 1 with malunion) in whom failure subsequently occurred due to instability (ie, failed primary RSA group) and revision for failure of a previous RSA in 22 patients (ie, failed revision RSA group)
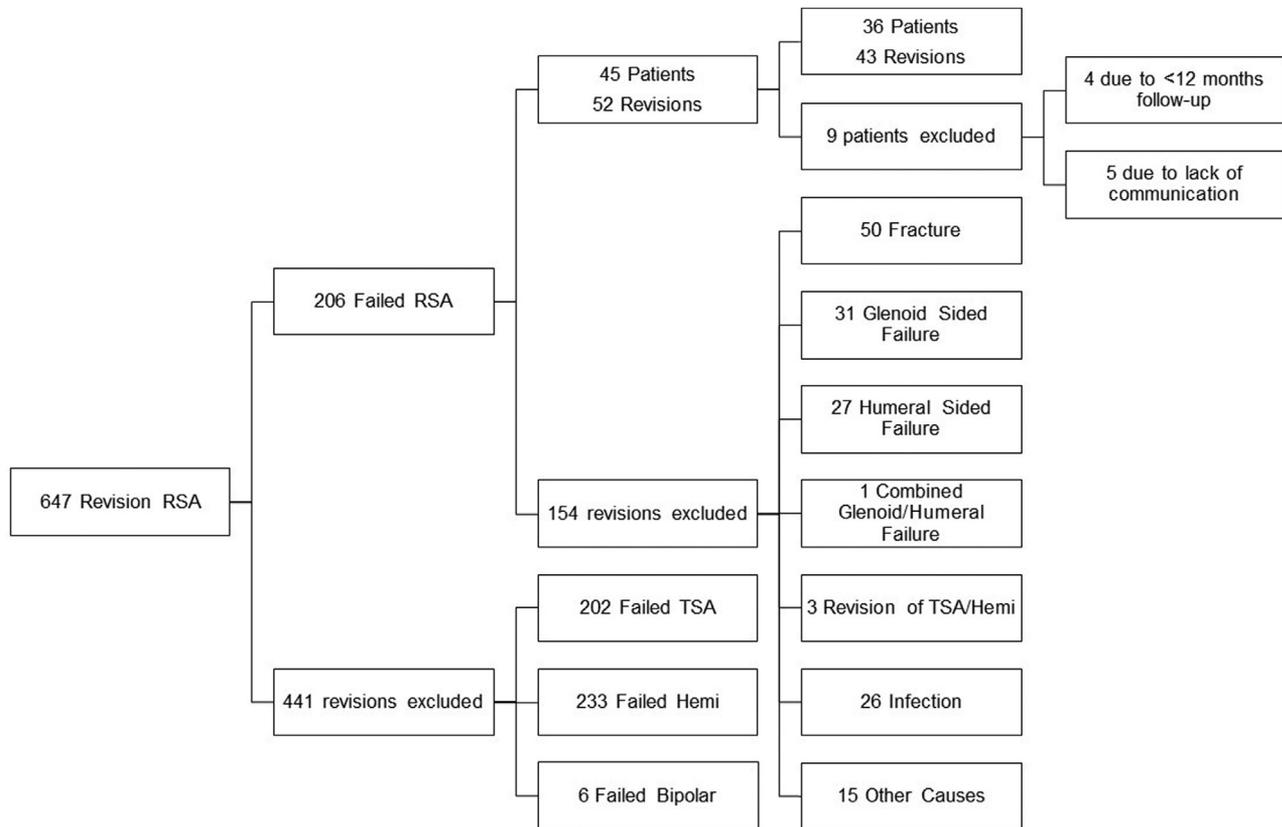
**Figure 1** Flowchart explaining how revision reverse shoulder arthroplasty (RSA) patients were identified. The exclusion criteria were defined as (1) revision to RSA after failed total shoulder arthroplasty (TSA) (n = 202), hemiarthroplasty (Hemi) (n = 233), or bipolar shoulder arthroplasty (n = 6) and (2) indications for revision of failed RSA (n = 206) other than instability, comprising fracture (n = 50); glenoid-sided failure (n = 31); humeral-sided failure (n = 27); combined humeral- and glenoid-sided failure (n = 1); revision of TSA or hemiarthroplasty (n = 3); infection (n = 26); and other causes including spacers, staged surgical procedures, and scapular and rotator cuff pathology (n = 15).

2. Previous attempt at stabilization at outside institutions, which occurred in a total of 14 patients (39%) and a total of 21 revisions prior to coming under the senior author's care
3. Mechanism of instability, defined based on a previously used classification system[1] (Table I) to include 4 main categories—loss of compression, loss of containment, impingement, and implant loosening
4. Clinical history of instability, in which revisions were performed for either recurrent instability (17 of 43 procedures [40%] [in 16 patients]), defined as multiple dislocation events that can be reduced with minimal effort, or chronically locked dislocations (26 of 43 procedures [60%] [in 20 patients]), defined as dislocation events in which reduction was unable to be achieved by closed methods
5. Surgical technique, including 3 glenoid side–only procedures (in 3 patients), 3 humeral side–only procedures (in 3 patients), and 37 procedures addressing both glenoid and humeral issues (in 31 patients)

The primary outcome measure was stability at last follow-up (53 ± 47 months), which was then compared regarding the studied factors: (1) indication, (2) previous attempt at stabilization, (3) mechanism of instability, (4) clinical history of instability, and (5) surgical technique. Additionally, PROMs (Simple Shoulder Test [SST], American Shoulder and Elbow Surgeons [ASES], and visual analog scale scores; forward flexion; abduction; internal rotation; and external rotation) at a minimum of 2 years were evaluated.

## Statistical analysis

Averages and standard deviations were reported for continuous variables, and percentages were reported for categorical variables. A paired $t$ test was used to evaluate improvements in PROMs, and an independent $t$ test or the Mann-Whitney test was used to draw comparisons. The $\chi^2$ test or Fisher exact test was used to evaluate the relationships between categorical variables. The level of statistical significance was set at $\alpha = .05$.

## Results

Our patient population consisted of 36 patients (12 female and 24 male patients, 20 right and 16 left shoulders) with a mean age of 68.9 ± 9.4 years and mean body mass index of 30.7 ± 6.

**Table I** Classification system for etiology of instability for revision

| Major category | Subcategory | Stable | Unstable | Total |
|---|---|---|---|---|
| Loss of compression | Undersized component | 10 | 3 | 13 |
| | Deltoid dysfunction | 1 | 2 | 3 |
| | Loss of deltoid contour | 2 | 1 | 3 |
| | Acromial fracture | 0 | 1 | 1 |
| | Humeral shortening | 1 | 0 | 1 |
| | Axillary nerve injury | 1 | 0 | 1 |
| Loss of containment | Alteration of D/R ratio | 1 | 0 | 1 |
| | Mechanical failure | 3 | 0 | 3 |
| Impingement | Prosthetic malalignment | 2 | 0 | 2 |
| | Soft-tissue impingement | 3 | 1 | 4 |
| | Bony impingement | 7 | 1 | 8 |
| Implant loosening | Humeral implant loosening | 1 | 2 | 3 |
| | Glenoid implant loosening | 0 | 0 | 0 |
| Total | | 32 | 11 | 43 |

## Stability at final follow-up

### Indication

Overall, stability was achieved in 32 of 36 patients (89%) at final follow-up (mean, $53 \pm 47$ months; range, 12-210 months). A single surgical attempt at stabilization was made in 29 patients, 26 (90%) of whom showed continued stability. A second attempt to stabilize the RSA (revision of failed revision surgery for instability by the senior author) was made in 7 patients (19%), with achievement of stability in 6 of 7 patients (86%) after the second attempt (mean follow-up, $37 \pm 36$ months; follow-up range, 12-108 months) but continued instability in 1 patient after the second attempt (the time between the first and second attempts to stabilize the RSA was 3 months, with final follow-up occurring at 12 months). A total of 38 revisions were required to achieve stability in the aforementioned 32 patients.

On comparison of stability by indication, stability was achieved in 13 of 14 patients (93%) in the failed primary RSA group at final follow-up (mean, $65 \pm 59$ months; range, 12-210 months) compared with 19 of 22 patients (86%) in the failed revision RSA group at final follow-up (mean, $45 \pm 36$ months; range, 12-148 months; $P = .365$). Two attempts at stabilization were made in only 1 patient in the failed primary group (7%, with achievement of stability at 108 months) vs. 6 patients in the failed revision group (27%; with achievement of stability, on average, at $22 \pm 9$ months; range, 12-32 months). The average number of any shoulder procedure performed per patient was 3 (range, 2-10) in the failed primary group vs. 4.5 (range, 3-7) in the failed revision group ($P = .008$).

### Previous attempt at stabilization at outside institution

Stability was achieved after revision in 12 of 14 patients (86%) with a history of failed stabilization procedures performed at outside institutions. These 12 patients required a total of 34 revisions, including 2 attempts in 4 patients, by the senior author to achieve stability (18 revisions from an outside facility, 12 first attempts at stabilization by the senior author, and 4 reattempts at stabilization by the senior author). There were 22 patients without a history of stabilization procedures, and stability was restored in 20 (91%). These 20 patients required a total of 22 revisions (20 first attempts at stabilization by the senior author and 2 reattempts at stabilization; $P = .634$) to achieve stability.

### Mechanism of instability

Of the 43 revision procedures, 22 were performed for instability attributed to loss of compression. Stability was achieved in 15 of these 22 cases (68%) at the last follow-up visit. Loss of containment accounted for 4 procedures, with achievement of stability in all 4 cases (100%). A total of 14 procedures were performed for impingement, with achievement of stability in 12 of 14 cases (86%). Finally, 3 procedures were performed for loose components, with achievement of stability in 1 of 3 cases (33%) ($P = .143$, Table I). Persistent instability was observed in patients with deltoid dysfunction (1 of 3), acromial fracture (1 of 1), soft-tissue impingement (1 of 4), and bony impingement (1 of 8).

### Clinical history of instability

There were 16 patients with recurrent instability, who underwent 19 total revisions. Stability was restored in 14 patients after 16 total revisions (88%). Out of 24 total revisions performed on 20 patients with chronically locked dislocations, 20 were successful (83%). Stability was restored in 18 patients after 20 total revisions (90%, $P = .813$) (Fig. 2).

### Surgical technique

Revisions to glenoid components alone were performed in 2 patients, with a 67% success rate at final follow-up
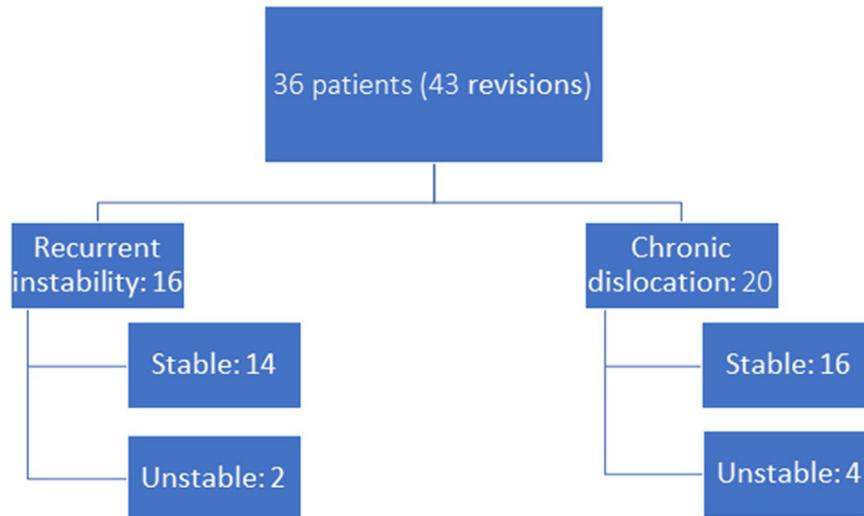
**Figure 2** Recurrent instability vs. chronic dislocation revisions.

(1 patient underwent re-revision via a bipolar technique). There were 3 patients with revisions isolated to the humeral components, with stability achieved in 2 of 3 (67%) at final follow-up. Finally, 31 patients underwent bipolar revisions, with stability achieved in 28 of 31 (90%) at final follow-up ($P = .404$).

## Outcome measures

Preoperative and postoperative outcomes at a minimum of 2 years were available for 18 of 21 patients (63%) in whom stability was achieved at the last visit, and significant improvements in the ASES score, forward flexion, abduction, external rotation, and the SST score were observed ($P = .016$, $P < .01$, $P = .01$, $P < .01$, and $P = .247$, respectively) (Table II). Patients receiving revision RSA after primary RSA had an average ASES score of $62 \pm 23$, whereas those receiving revision for failed arthroplasty had an average ASES score of $60 \pm 20$ ($P = .810$).

## Discussion

Instability after revision RSA can be a challenging complication to properly address.[1] In our cohort, patients in the failed revision RSA group were more likely to experience continued instability after receiving a procedure to address instability than patients in the failed primary RSA group (27% vs. 7%). Failed revision RSA patients required more revisions to achieve stability. In addition, it was hypothesized that patients with a history of failed surgical procedures to address an unstable implant would experience high rates of continued instability and worse clinical outcomes; 82% of patients in this group showed continued stability after revision.

Regarding surgical tactics, their utilization for each category of instability will vary depending on the underlying pathology. For example, in patients with instability due to loss of compression associated with humeral shortening, efforts to restore humeral length, such as removing the previous implant and adding a proximal humeral allograft to help restore humeral bone loss, can be helpful. Alternatively, if the patients' components are undersized because of a thinner (more medial offset) glenosphere, then selecting a thicker (more lateralized) glenosphere will be effective. Increasing soft-tissue tension with larger components is often required when addressing loss of containment, in addition to restoring the articulation (either because of taper failure or eccentric polyethylene wear). Removing scar tissue that may lead to asymmetrical tightness of the soft tissue must be performed when discussing the treatment of impingement. This often includes removing scar in the subdeltoid space, which may be in close proximity to the axillary nerve. Finally, revising an unstable reverse arthroplasty in the setting of a loose component again requires the secure attachment of the components with an appreciation that the soft tissues may be significantly petulant or conversely scarred.

It is also important to remember that radiographic outcomes and clinical outcomes do not necessarily correlate.[10] It was difficult to adequately describe all the intricacies involved in each procedure, and the unique properties of each patient case made it challenging to generalize into groups. Some patients also lacked detailed histories, leading to problems in describing their initial indications for arthroplasty. Given the complexities of each patient case, it was challenging to define the relationship of the underlying pathology and how to manage that pathology. This classification scheme was applied to each unique case to properly organize this population into subgroups. However, we did recognize that although these suggestions could be applied generally, these recommendations would not completely address all the issues inherent in each patient case.[9,19] Patients in whom dislocation remained at final follow-up

**Table II** Patient-reported outcome measures in patients with achievement of stability at final follow-up

| Outcome measure | Preoperative | Final follow-up | P value |
|---|---|---|---|
| ASES total score | 47 ± 26 | 62 ± 21 | .016[*] |
| Forward flexion, ° | 39 ± 45 | 112 ± 62 | <.01[*] |
| Abduction, ° | 37 ± 42 | 96 ± 55 | .01[*] |
| External rotation, ° | 14 ± 53 | 42 ± 31 | <.01[*] |
| SST score | 4 ± 3 | 6 ± 4 | .247 |

*ASES*, American Shoulder and Elbow Surgeons; *SST*, Simple Shoulder Test.
Data are presented as mean ± standard deviation.
[*] Statistically significant (P < .05).

presented particularly challenging cases to define, especially when these patients continued to function while their shoulders were classified as unstable.[18,20,22] Although this made it difficult to divide the population further, it is believed that this series presents a fairly accurate description of the unique surgical pathology in this surgical population.

This study presents a unique, complex population that has not been studied before. Although a prior study looked at instability after RSA, the majority of the study population experienced instability after failed primary RSA,[7] whereas the majority of the revisions in our cohort were treated for instability after failed revision RSA. Although it was difficult to describe this complex population adequately and succinctly, we did use previous classification schemes as a surrogate to identify the different types of instability in this population.[1,7,22]

Management of the unstable RSA offers several challenges including identification of the mechanism and accompanying pathology of instability, decision-making about appropriate implant sizing and possible use of allograft or tumor type of prosthesis, and surgical experience to remove scar close to neurovascular structures. Although outcomes following revision surgery for instability are comparable to outcomes of revision procedures for other indications, it is important to counsel patients early on that multiple surgical procedures may be needed to achieve stability and that this is a complex problem with many variables to take into consideration.[2,12,13,15,16]

## Conclusion

A minimal difference in stability at final follow-up was observed between the failed primary RSA and failed revision RSA patient groups. Loss of compression with loss of deltoid tension and soft-tissue impingement represented the most common causes of persistent instability. Regarding surgical technique, most revisions were completed with bipolar changes (50 of 59), and continued stability was observed in 34 of 50 cases

(68%). Humeral-sided revisions remained stable in 5 of 7 cases (71%), whereas glenoid-sided revisions remained stable in 1 of 2 cases (50%). Unstable revisions presenting with loss of compression were treated with all 3 surgical techniques: glenoid side only (1 of 8, 12.5%), humeral side only (1 of 8, 12.5%), and bipolar changes (6 of 8, 75%). Both revisions classified by loss of deltoid tension (2 cases) remained unstable after bipolar changes (2 of 2 cases). Revisions presenting with soft-tissue impingement were treated with humeral side–only procedures (1 of 2 cases) or bipolar changes (1 of 2 cases). Patients in both groups showed statistically significant improvements in PROMs from preoperatively to postoperatively, except the SST score.

Patients who present with an unstable reverse shoulder prosthesis vary in their complexity. They often will have undergone multiple previous surgical procedures. Despite this, we were able to achieve stability in 32 patients and improve their quality of life.

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