J Shoulder Elbow Surg (2024) 33, 707–714

ELSEVIER

Journal of Shoulder and Elbow Surgery

www.elsevier.com/locate/ymse

Revision reverse shoulder arthroplasty for the management of baseplate failure: an analysis of 676 revision reverse shoulder arthroplasty procedures

Mitchell P. John II, MD[a,*], John T. Wilson, MD[a], Lazaro Mesa, MD[a], Peter Simon, PhD[b], Mark A. Frankle, MD[b,c]

[a]*Department of Orthopaedic Surgery, University of South Florida, Tampa, FL, USA*
[b]*Foundation of Orthopaedic Research and Education, Tampa, FL, USA*
[c]*Shoulder Service, Florida Orthopaedic Institute, Tampa, FL, USA*

Background: Baseplate failure in reverse shoulder arthroplasty (RSA) is a rare but potentially catastrophic complication owing to poor patient outcomes and significant glenoid bone loss. The purpose of this study was to report on the prevalence, causes, and outcomes of revision RSA (rRSA) for baseplate failure or loosening.

Methods: A retrospective review of our institutional database was performed to identify all patients treated for a failed RSA from 2006 to 2021 who required revision to another RSA (rRSA) performed by a single surgeon. A total of 676 failed RSA procedures were identified, and further analysis identified 46 patients (6.8%) who underwent rRSA for baseplate failure with a confirmed loose baseplate at the time of rRSA. The primary outcome was repeated failure of the reimplanted baseplate following rRSA. The mode of failure associated with baseplate failure was stratified into 1 of 3 groups: aseptic, septic, or traumatic. Twenty-four patients underwent primary revision, and 22 had undergone >1 previous arthroplasty prior to undergoing re-revision. Five patients underwent previous rRSA for baseplate failure performed by an outside surgeon. The criteria for secondary outcome analysis of final American Shoulder and Elbow Surgeons score, Simple Shoulder Test score, and range of motion were met by 32 patients and 23 patients at 1- and 2-year follow-up, respectively.

Results: Three patients (6.5%) had repeated baseplate failure requiring re-revision; 2 had baseplate failure at <1 year with associated periprosthetic infections and underwent conversion to hemiarthroplasty. The third patient experienced traumatic failure at 10 years and underwent successful rRSA. The mean American Shoulder and Elbow Surgeons scores at 1 and 2 years were 62.3 and 61.7, respectively. There was no significant difference in outcomes based on mode of baseplate failure ($P = .232$) or total arthroplasty burden ($P = .305$) at 1 year. There were 13 total complications in 11 patients, 5 of which required reoperation for reasons other than baseplate failure.

Conclusion: In this study, rRSA for baseplate failure constituted 6.8% of all revisions performed over a period of 15 years. Re-revision for recurrent baseplate failure was required in 3 of 46 patients (6.5%). Complications and reoperation rates were higher than those for primary RSA but outcomes were comparable for revision of failed anatomic shoulder arthroplasty.

The University of South Florida Institutional Review Board determined this study to be exempt from requiring approval.

*Reprint requests: Mitchell P. John II, MD, 5 Tampa General Circle, Suite 710, Tampa, FL 33606, USA.
E-mail address: mitchellpjohn@gmail.com (M.P. John).

https://doi.org/10.1016/j.jse.2023.06.039

Level of evidence: Level IV; Case Series; Treatment Study

Keywords: Reverse shoulder arthroplasty; revision shoulder arthroplasty; baseplate failure; RSA; rRSA

Reverse shoulder arthroplasty (RSA) is an increasingly common surgical procedure with expanding indications owing to its success in restoring function and relieving pain in the pathologic shoulder.[6-8,11,15,20,29,30] Epidemiologic data estimated an increase in the incidence of primary RSA from 7.3 to 19.3 per 100,000 from 2012 to 2017 including use in younger patients, who studies suggest may be at higher risk of revision procedures.[1,4] With the increase in RSA volume, the numbers of failures and complications are expected to increase accordingly.[4,6,8] Given the growing demand, both surgeons' competency in the revision setting and an understanding of associated complications are imperative for optimizing patient outcomes.

In early implant designs, baseplate loosening and mechanical failure were not uncommon.[11,13] Modern-day glenoid-sided failure is less common, but etiologies include mechanical loosening, aseptic or septic loosening, fracture, and glenosphere dissociation.[20,21,24] Current evidence demonstrates a modern RSA survival rate >90% at a minimum 10-year follow-up,[2,10] and current rates of glenoid aseptic failure are estimated to be 1%-2%.[5,24]

Revision of anatomic total shoulder arthroplasty (TSA) to RSA for glenoid sided failure has demonstrated an improvement in patient outcomes, albeit with increased overall complication and re-revision rates.[3,14,20,22,25,29] However, regarding revision RSA performed for baseplate failure, there is a significant paucity of existing literature to guide both surgeons and patients. An early small series from our institution showed improved outcomes with low complication and re-revision rates after baseplate failure.[21]

The purpose of this study was 2-fold: (1) to report on the frequency and causes of revision RSA (rRSA) for baseplate failure and (2) to report on the outcomes and implant survival of rRSA. The primary endpoint was failure of the reimplanted baseplate (from rRSA) at any time during follow-up, and secondary outcomes include patient-reported outcome measures (PROMs) at 1 year, 2 years, and final follow-up.

Methods

A retrospective chart review was performed to identify all patients who underwent rRSA from 2006 to 2021 performed by a single surgeon (M.A.F.) (Fig. 1). Patient charts, radiographs, and operative notes were reviewed to include only patients who underwent rRSA with a loose or failed glenoid baseplate. Those with glenosphere dissociation and those without a loose or failed baseplate who underwent revision for other reasons were excluded.

A total of 676 rRSA procedures were performed in the study interval. Of these 676 procedures, 46 (6.8%) were confirmed to be rRSA procedures performed for baseplate failure or loosening. As the standard of care, patients are scheduled for clinical and radiographic follow-up within the first year postoperatively and at the 2-year mark, and they are further encouraged to follow-up annually. PROMs are collected during patient visits, via e-mail, and in some instances, over the phone (patients are contacted to provide PROMs when ≥3 consecutive instances of missed follow-up occur). In this cohort, 3 patients had follow-up of <1 year, 2 patients were confirmed to have died of unrelated causes, and 6 patients had critical missing data for unexplained causes and were contacted on 2 separate occasions without success (when patients do not respond to repeated attempts or they respond but choose not to participate further, this is considered critical noncompliance and restricts any future e-mails or calls).

The primary endpoint of repeated failure was met by 2 patients prior to 1 year and by a third patient at 10 years, excluding these patients from secondary PROM analysis. The resulting final analysis included 32 patients with a minimum of 1 year of follow-up (mean, 36.1 months; range, 10-103 months) and 23 patients with a minimum of 2 years of follow-up (mean, 45.7 months; range, 19-103 months) who met the PROM and radiographic criteria for secondary postoperative analysis.

The mode of failure was determined by consensus of 3 reviewers after reviewing the operative notes and was stratified into 1 of 3 groups: aseptic, septic, or traumatic. There were 23 patients with aseptic failure (negative frozen section results), defined by radiographic findings as described by Cuff et al[10] and Holcomb et al[21]; 9 patients with septic loosening, defined as a loose or failed baseplate with positive frozen section results and positive intraoperative culture findings necessitating treatment with intravenous antibiotics; and 14 patients with traumatic failure, consisting of an explicit traumatic event followed by a change in shoulder pain or function and radiographic evidence of failure (baseplate migration or screw breakage) with negative frozen section results (Fig. 2).

Perioperative data evaluated at the time of our rRSA procedures included patient demographic characteristics (age, sex, body mass index), comorbidities (smoking history, diabetes, chronic narcotic use, rheumatologic disease, immunocompromised state) (Table I), prosthesis type (primary RSA implant), failure mechanism (aseptic, septic, or traumatic), and number of and reason for previous shoulder arthroplasties (history of additional shoulder arthroplasties and type). Intraoperative data evaluated included surgical indication, glenoid bone loss, rotator cuff status, humeral bone loss, evidence of implant stability, type of implant used, intraoperative frozen section findings, and tissue culture results. Postoperative radiographs were evaluated for evidence of repeated loosening, mechanical failure, periprosthetic fracture, humeral loosening, and glenohumeral instability. The primary endpoint was failure of the reimplanted baseplate (from rRSA) at any time during follow-up. Secondary outcomes were

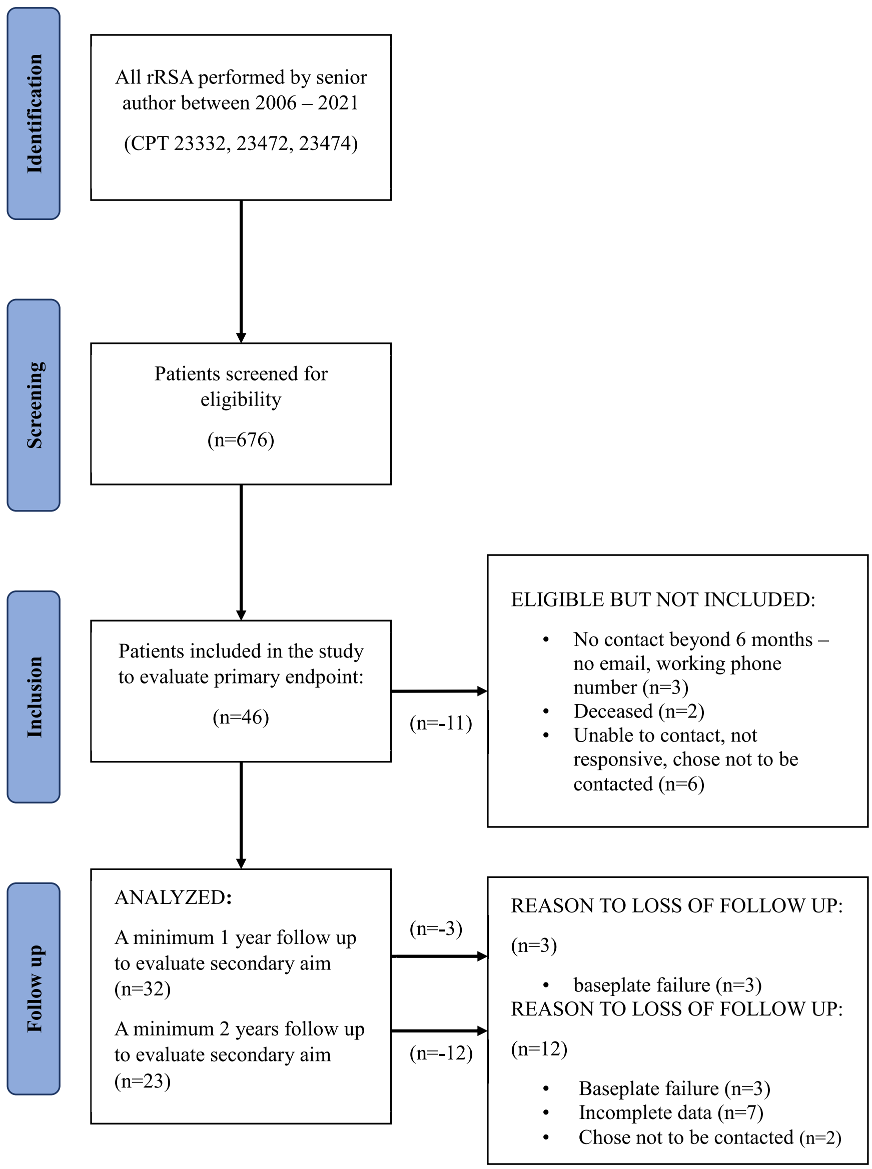

Figure 1 Chart review and inclusion flowchart. *rRSA*, revision reverse shoulder arthroplasty; *CPT*, Current Procedural Terminology.

reported at 1 year, 2 years, and final follow-up, including range of motion (ROM), visual analog scale (VAS) pain score, Simple Shoulder Test (SST) score, American Shoulder and Elbow Surgeons (ASES) score, and radiographs. Complications overall were stratified into major and minor, where any complications requiring additional surgery were considered major complications, excluding those meeting the primary endpoint.

Surgical technique

In all patients, a preoperative computed tomography study of the affected shoulder was performed to evaluate glenoid bone and assist with surgical planning. Of 46 operations, 45 were performed using an off-the-shelf commercially available implant (DJO RSA; Enovis, Austin, TX, USA). One patient underwent revision to a custom prefabricated glenoid component because it had already been manufactured by the previous treating surgeon prior to referral to our clinic. Nine different implant types were revised in this study.

A standard deltopectoral approach was performed with the patient in the beach-chair position. The joint was entered via subscapularis peel and anterior capsulectomy, followed by glenohumeral joint dislocation to expose the glenoid. The humeral component was left in place. The glenoid baseplate was assessed for loosening if it was not already dissociated from the remaining glenoid bone. Once determined to be loose, the glenosphere and baseplate were removed carefully to minimize additional glenoid bone loss. Broken screws were usually left in place to preserve remaining glenoid bone stock. In circumstances in which there was less than approximately 50% of osseous contact between the glenoid bone and backside of the baseplate, the decision to use structural allograft (all femoral head allograft) and/or bone morphogenetic protein 2 (BMP-2) was made at this time.

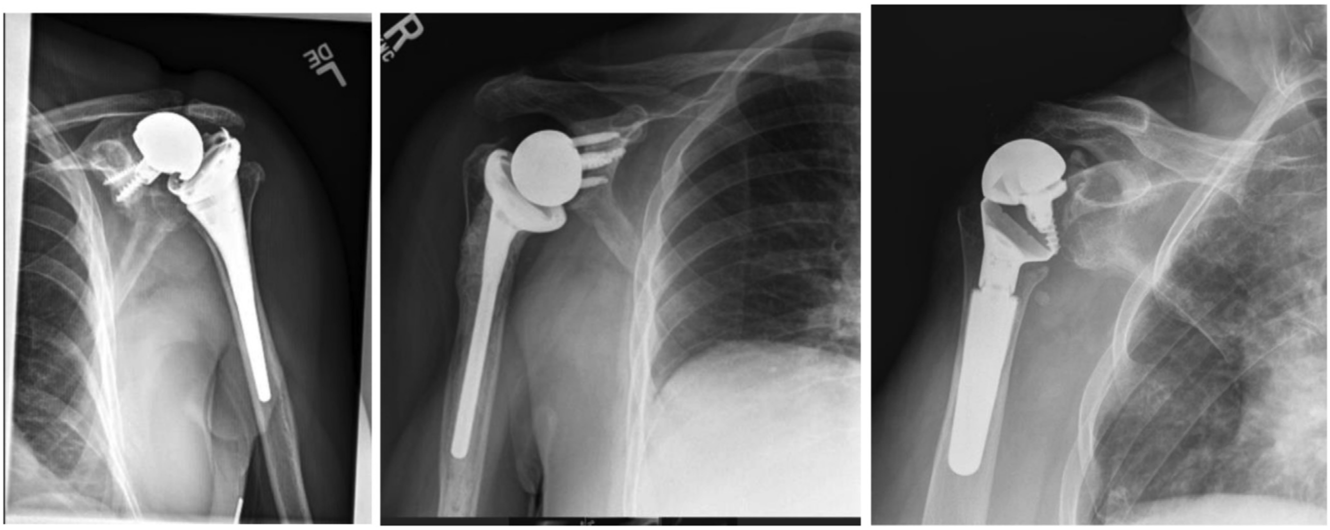

Figure 2 Examples of aseptic baseplate failure (*left*), septic baseplate failure (*middle*), and traumatic baseplate failure (*right*). *L*, left; *R*, right.

Allograft was shaped to contour the defect, provisionally fixed with K-wires, and reamed using cannulated reamers. The baseplate was then fixed into place with a 6.5-mm central screw and four 5-mm peripheral locking screws; however, in rare cases, a variable-angle 3.5-mm cortical screw was used to access limited glenoid bone when the altered revision glenoid could not accommodate a fixed-angle 5-mm locking screw in one of the holes. Rarely, the holes in the baseplate could not accommodate any screw because of glenoid morphology, but in all cases, at least two 5-mm locking screws were used. To manage glenoid defects, femoral head allograft was used in half of our revisions (23 patients); 39% of patients (n = 18) received BMP-2, and 50% (n = 23) underwent revision to a larger glenosphere. Glenoid defects were classified as severe in 50% of cases, moderate in 48%, and mild in 2%. The majority of the defects were in the central glenoid (63%). In 10 patients, the revision baseplate was placed in the alternative center line position; in the remainder, it was placed on the standard face of the glenoid.[9] After stability of the glenoid construct was ensured, attention was turned to the humeral component, where the stem and humeral socket were assessed for stability. In cases in which the humeral implant was judged to be stable and in an acceptable position, the stem was left in place. A hybrid construct was used in 8 of 46 cases, and the humeral stem was revised in 8 of 46 cases. Nine patients had positive intraoperative frozen section and culture results and underwent treatment for infection. They all received a single-stage revision with removal of loose and modular components and 6 weeks of intravenous antibiotic administration. A total of 9 different implants were revised (Table II). Perioperative characteristics are listed in Table III. Postoperatively, all patients were placed in a standard sling for 2 weeks with only gentle ROM exercises consisting of pendulums; active assisted motion began at 6 weeks.

Table I Demographic characteristics of 46 patients in total

	Data
Mean follow-up (range), mo	31.5 (2-112)
Mean age (range), yr	69.3 (47-88)
Female sex, n (%)	21 (46)
Obesity (BMI >29.9), n (%)	21 (46)
Active smoker, n (%)	3 (7)
History of smoking, n (%)	22 (48)
Diabetes mellitus, n (%)	6 (13)
Autoimmune disease, n (%)	7 (15)
Long-term narcotic use, n (%)	9 (20)

BMI, body mass index.

Statistical analysis

To evaluate the prevalence of rRSA and to report on its causes, we considered every patient who met the inclusion criteria of confirmed failed RSA owing to baseplate failure or loosening. To report on the outcomes of rRSA at 1 year, we included every case that met both the time requirement (minimum 1-year follow-up visit) and the successful revision requirement (Fig. 1).

Continuous variables are presented as averages and standard deviations. Categorical variables are presented as proportions. Independent and paired *t* tests were used to evaluate continuous variables, whereas the Fisher exact test and χ^2 analysis were used to evaluate categorical variables. The α level was set at 0.05.

Results

Prevalence of baseplate failure after rRSA

In our cohort, 3 patients (6.5%) experienced repeated baseplate failure. Two had septic failure with subsequent baseplate loosening and underwent conversion to hemiarthroplasty at 1.9 and 8.9 months. The third patient had a successful outcome after the index rRSA procedure for

Table II Revised baseplates

	n
Failed implant	
DJO (Enovis, Austin, TX, USA)	25
Zimmer (Zimmer-Biomet, Warsaw, IN, USA)	4
Wright (Wright Medical, Memphis, TN, USA)	3
Biomet (Zimmer-Biomet)	3
Arrow (FH ORTHO, Quimper, Brittany, France)	4
Exactech (Exactech, Inc, Gainesville, FL, USA)	4
Other	3
Total	46

baseplate failure for nearly 10 years but then experienced repeated traumatic failure. He underwent successful re-revision to another RSA.

Outcomes after rRSA

Overall final outcome scores are reported for the 1- and 2-year follow-up groups in Table IV, with ASES scores of 62.3 (n = 32; mean follow-up, 36.1 ± 26.6 months) and 61.7 (n = 23; mean follow-up, 45.7 ± 25.6 months), respectively. The mean ASES and SST scores at final follow-up for all patients were 62.7 ± 25.8 and 6.1 ± 4, respectively. The mean VAS pain score at final follow-up was 2.9 ± 2.8. Final forward flexion and abduction measured 137° ± 59° and 121° ± 57°, respectively (Table V). There was no difference in ASES, SST, or VAS pain scores based on mode of failure (aseptic, septic, or traumatic) or primary revision vs. multiple revision patients at 1 and 2 years. Time to failure was highly variable and was not associated with failure mechanism.

Subgroup analysis of patients who had a previous failed TSA showed that these patients underwent an average of 3 shoulder arthroplasty procedures prior to rRSA for baseplate failure compared with an overall average of 1.7 shoulder arthroplasty procedures for all other indications. About half

Table III Perioperative characteristics

Perioperative variable	Data	*P* value
History of TSA, n (%)	15 (33)	.549
Previous baseplate revision by outside surgeon, n (%)	5 (11)	.886
Mean no. of prior arthroplasties	1.7	.687
No. of prior arthroplasties, n (%)		
1	24 (52)	
2	14 (30)	
≥3	8 (17)	
Scapular notching, n (%)	12 (26)	.414
Use of bone graft, n (%)	23 (50)	.631
Use of BMP-2, n (%)	18 (39)	.491
Use of larger glenosphere, n (%)	23 (50)	.780
Use of alternative spine line, n (%)	10 (22)	
Glenoid defect size, n (%)		.545
Mild	1 (2)	
Moderate	22 (48)	
Severe	23 (50)	
Glenoid defect location, n (%)		.590
Central	29 (63)	
Posterior	9 (20)	
Superior	8 (17)	

TSA, total shoulder arthroplasty; *BMP-2*, bone morphogenetic protein 2.
Data are presented as number (percentage) unless otherwise indicated.

Table IV Patient-reported outcomes at 1 and 2 years stratified by mode of failure

Revision indication	Count	Mean	SD	*P* value
1 yr				
Aseptic				
ASES total score	17	69.5	24.2	
SST score	17	6.3	4.4	
VAS pain score	17	2.2	2.6	
Septic				
ASES total score	8	58.5	26.1	
SST score	8	5.6	4.0	
VAS pain score	8	3.7	2.7	
Traumatic				
ASES total score	7	49.0	33.9	
SST score	7	4.4	4.6	
VAS pain score	7	3.9	3.4	
Total				
ASES total score	32	62.3	27.4	.232
SST score	32	5.7	4.3	.553
VAS pain score	32	3.0	2.8	.271
2 yr				
Aseptic				
ASES total score	13	67.6	25.1	
SST score	13	5.7	4.5	
VAS pain score	13	2.2	2.6	
Septic				
ASES total score	5	64.3	30.5	
SST score	5	5.8	3.3	
VAS pain score	5	2.8	3.0	
Traumatic				
ASES total score	5	43.7	34.3	
SST score	5	3.4	4.0	
VAS pain score	5	4.6	3.8	
Total				
ASES total score	23	61.7	28.7	.29
SST score	23	5.2	4.1	.559
VAS pain score	23	2.87	3.0	.336

SD, standard deviation; *ASES*, American Shoulder and Elbow Surgeons; *SST*, Simple Shoulder Test; *VAS*, visual analog scale.

Table V Patient-reported outcomes of all patients at final follow-up

Outcome	Data
ASES score	62.7 ± 25.8
SST score	6.1 ± 4.0
VAS pain score	2.9 ± 2.8
Mean abduction, °	120.8 ± 56.6
Mean forward flexion, °	137.2 ± 59.0
Mean external rotation, °	51.9 ± 31.7
Mean internal rotation	4.9 ± 2.9

ASES, American Shoulder and Elbow Surgeons; *SST*, Simple Shoulder Test; *VAS*, visual analog scale.
Data are presented as mean ± standard deviation.

Table VI Postoperative findings in all patients

Complication	n
Minor	8
Hematoma	2
Instability	2
Superficial infection	1
Periprosthetic humeral fracture (nonoperative)	2
Brachial plexopathy	1
Major (reoperation, not for primary outcome)	5
Graft screw removal	1
Humeral revision	2
Deep infection (stable baseplate)	1
Glenosphere dissociation	1
Radiographic glenoid lucency	1 (3%)

A total of 13 complications occurred in 11 patients.

of the patients underwent only 1 previous arthroplasty procedure (24 of 46 patients, 52%) prior to our revision for a failed baseplate, whereas 22 patients (48%) required a second, third, or fourth revision arthroplasty. Five patients underwent previous rRSA for baseplate failure performed by an outside surgeon and subsequently had repeated failure prior to successful repeated rRSA at our facility. Perioperative characteristics are displayed in Table III.

Thirteen total complications were recorded in patients with ≥1 year of follow-up. Eight minor complications were recorded in 8 patients, including 1 case of peripheral nerve palsy, 2 hematomas, 2 cases of instability that resolved, 1 superficial wound infection treated with oral antibiotics, and 2 nonoperatively managed periprosthetic humeral fractures. In 4 patients, 5 additional shoulder operations were performed for reasons other than the primary endpoint, including 2 late humeral revisions (1 case of late humeral loosening and 1 case of periprosthetic fracture), 1 graft screw removal, 1 glenosphere dissociation, and 1 irrigation and débridement for infection with a stable baseplate (Table VI). A single patient accounted for 3 of the aforementioned complications.

Discussion

Baseplate failure is an uncommon complication in the modern era of RSA, accounting for an estimated 1.16%-10.4% of revision surgical procedures and is less common than revision for instability or infection, with specific rates of each varying by implant and period.[6,20,24,26,27,29] With the increasing number of RSAs being performed, the prevalence of baseplate failures needing revision surgery will predictably continue to increase.[4,8,15,17,20,30] In our 15-year retrospective cohort of rRSA patients, baseplate failure accounted for 6.8% of rRSA indications and the rate of repeated baseplate failure after our reimplantation of a baseplate was 6.5% (3 of 46 patients).

The PROMs in this study are similar to those presented in previous revision shoulder arthroplasty studies. It is difficult to make a direct comparison, however, because of heterogeneity across studies, with most studies having reported on mixed etiologies of failure, indications for revision, and types of implants or surgical techniques used. A study of revision to RSA for all types of arthroplasty failure (TSA, RSA, and hemiarthroplasty) reported final mean ASES and SST scores of 66 and 6.0, respectively, and noted lower 2- and 5-year implant survival rates in patients who required glenoid bone grafting.[28] In our study cohort, half of the patients required glenoid bone grafting, resulting in successful revision. Franke et al[14] reported on failed TSA revised to RSA in 123 patients, of whom 18 (11.4%) required re-revision. The final mean ASES scores were 67 and 55 in patients with and without intact rotator cuffs, respectively. Franke et al noted an increased risk of re-revision in TSAs revised with loose glenoid components. A small 2009 study of baseplate failures revised with rRSA reported significant improvements in pain, ROM, and mean postoperative ASES and SST scores (70 and 4.5, respectively) at an average follow-up of 35 months.[21] In a recent review of the available literature analyzing outcomes following rRSA for all causes, Chalmers et al[7] found a mean reported ASES score of 63 in an analysis of 9 studies reporting on rRSA procedures. Our study demonstrated comparable mean ASES scores of 62.3 and 61.7 at 1 and 2 years, respectively.

Outcomes stratified by failure mechanism or number of previous arthroplasties did not demonstrate any significant difference. However, patients who underwent revision for septic failure more often had undergone >2 prior arthroplasty procedures. Previous studies have demonstrated that patients with previous TSA may be at a higher risk of revision and baseplate failure when undergoing revision to RSA.[3,14] In their study of RSA for failed TSA, Bartels et al[3] treated 16 patients who underwent baseplate failure of the RSA conversion. Only 1 of these patients was successfully treated with rRSA. The results of our study do not suggest that patients with previous TSA revised to RSA have a higher risk of repeated baseplate failure or experience inferior outcomes compared with those with a single prior failed RSA.

This study demonstrates that rRSA for the management of baseplate failure is a reliable option with a low repeated failure rate and a modest improvement in outcomes regardless of the baseplate failure mechanism or the number and type of previous arthroplasties. Our results suggest that with improved surgeon understanding of specific implant technology, design, and surgical techniques a modest improvement in patient outcomes are attainable. We used an array of described surgical techniques in our rRSA procedures when indicated, including the application of bone graft, BMP-2, larger glenospheres,[23] locking screws,[19] and alternate baseplate positioning.[9,18] Bone allograft was one of the most commonly used applications (50% of cases). A retrospective study by Wagner et al[28] evaluated the use of glenoid bone graft in rRSA for glenoid bone loss in 40 patients. They found that 10% required re-revision for repeated baseplate failure and 3 underwent revision to hemiarthroplasty. Their study noted a lower 5-year survival rate in the bone graft group, which the authors attributed to selection bias in this difficult problem.[28] Our study did not find an association with increased failure with the use of bone graft for glenoid defects, and at a time of growing enthusiasm for augmented baseplates, we find bone grafting of glenoid defects to remain a reliable technique for baseplate fixation when implemented correctly. Glenosphere placement and position were ultimately dictated by available bone stock. For secure fixation in limited glenoid bone, we used locking screws as much as possible, in addition to larger glenospheres to increase backside contact, which both confers increased stability and secures the added bone graft.[23] Moreover, in several of our patients, the baseplate was positioned along the alternate spine line, which has been shown to be effective in circumstances with severe glenoid bone defects.[9,12,16]

A novel point of this study is the focus on rRSA for baseplate failure alone and subsequent subgroup stratification based on failure type and overall arthroplasty burden. Several studies evaluating rRSA for all causes and RSA within the context of glenoid bone loss do exist, but a paucity of studies dedicated to outcomes after revision to RSA for baseplate failure remains. Additionally, including patients who have undergone multiple revisions and including baseplate failures from several different RSA systems increases real-life application and generalizability. Our study works to bridge this gap, demonstrating that rRSA following baseplate failure for multiple different etiologies can produce reliable outcomes at 1 and 2 years.

Limitations of this study include the fact that the revisions were performed with a single type of implant, and the tools and techniques used may not be applicable universally. This is a retrospective review of a single surgeon's experience at a large referral center, and many of the patients undergoing revision presented from the community. In several instances, this contributed to difficulty in obtaining some records preoperatively, limited standardized postoperative follow-up, and limited our ability to evaluate and make conclusions regarding patient, surgeon, and technical factors that may have contributed to the original failure. Finally, only 6.5% of all indicated rRSA procedures were performed for baseplate failure in our cohort, and as such, analysis of this uncommon complication is limited by the availability of the problem itself.

Conclusion

Baseplate failure in modern RSA is an uncommon but difficult problem to manage. Regardless of the method of baseplate failure or total arthroplasty burden, management with rRSA and standard baseplate reimplantation can result in successful outcomes with modest improvements in pain and PROMs at 1 and 2 years, complication rates comparable to rRSA for all causes, and low rates of repeated baseplate failure.

Disclaimers:

Funding: Funding for this study was provided by Enovis. Enovis had no control over data analysis or the content of this manuscript.

Conflicts of interest: Peter Simon receives research support from CoreLink and Enovis. The research institution with which this author is affiliated receives research support from Enovis. Mark A. Frankle receives royalties, research support, and consulting fees from Enovis; is a paid presenter or speaker for Enovis; and receives consulting fees from Synchrony Healthcare Communications. The other authors, their immediate families, and any research foundations with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.

References

1. Aibinder W, Schoch B, Parsons M, Watling J, Ko JK, Gobbato B, et al. Risk factors for complications and revision surgery after anatomic and reverse total shoulder arthroplasty. J Shoulder Elbow Surg 2021;30:e689-701. https://doi.org/10.1016/j.jse.2021.04.029
2. Bacle G, Nové-Josserand L, Garaud P, Walch G. Long-term outcomes of reverse total shoulder arthroplasty: a follow-up of a previous study. J Bone Joint Surg Am 2017;99:454-61. https://doi.org/10.2106/JBJS.16.00223
3. Bartels DW, Marigi E, Sperling JW, Sanchez-Sotelo J. Revision reverse shoulder arthroplasty for anatomical glenoid component loosening was not universally successful: a detailed analysis of 127 consecutive shoulders. J Bone Joint Surg Am 2021;103:879-86. https://doi.org/10.2106/JBJS.20.00555

4. Best MJ, Aziz KT, Wilckens JH, McFarland EG, Srikumaran U. Increasing incidence of primary reverse and anatomic total shoulder arthroplasty in the United States. J Shoulder Elbow Surg 2021;30: 1159-66. https://doi.org/10.1016/j.jse.2020.08.010
5. Bitzer A, Rojas J, Patten IS, Joseph J, McFarland EG. Incidence and risk factors for aseptic baseplate loosening of reverse total shoulder arthroplasty. J Shoulder Elbow Surg 2018;27:2145-52. https://doi.org/10.1016/j.jse.2018.05.034.52
6. Boileau P. Complications and revision of reverse total shoulder arthroplasty. Orthop Traumatol Surg Res 2016;102:S33-43. https://doi.org/10.1016/j.otsr.2015.06.031
7. Chalmers PN, Boileau P, Romeo AA, Tashjian RZ. Revision reverse shoulder arthroplasty. J Am Acad Orthop Surg 2019;27:426-36. https://doi.org/10.5435/JAAOS-D-17-00535
8. Cheung E, Willis M, Walker M, Clark R, Frankle MA. Complications in reverse total shoulder arthroplasty. J Am Acad Orthop Surg 2011; 19:439-49. https://doi.org/10.5435/00124635-201107000-00007
9. Colley R, Polisetty TS, Levy JC. Mid-term outcomes of reverse shoulder arthroplasty using the alternative center line for glenoid baseplate fixation: a case-controlled study. J Shoulder Elbow Surg 2021;30:298-305. https://doi.org/10.1016/j.jse.2020.05.012
10. Cuff DJ, Pupello DR, Santoni BG, Clark RE, Frankle MA. Reverse shoulder arthroplasty for the treatment of rotator cuff deficiency: a concise follow-up, at a minimum of 10 years, of previous reports. J Bone Joint Surg Am 2017;99:1895-9. https://doi.org/10.2106/JBJS.17.00175
11. Cuff D, Pupello D, Virani N, Levy J, Frankle M. Reverse shoulder arthroplasty for the treatment of rotator cuff deficiency. J Bone Joint Surg Am 2008;90:1244-51. https://doi.org/10.2106/JBJS.G.00775
12. Cuff D, Simon P, Gorman RA II. Mid-term outcomes of reverse shoulder arthroplasty using the alternate scapular line baseplate orientation for glenoid bone loss. Semin Arthroplasty 2021;31:51-7. https://doi.org/10.1053/j.sart.2020.10.003
13. Flatow EL, Harrison AK. A history of reverse total shoulder arthroplasty. Clin Orthop Relat Res 2011;469:2432-9. https://doi.org/10.1007/s11999-010-1733-6
14. Franke KJ, Christmas KN, Simon P, Mighell MA, Frankle MA. The effect of glenoid bone loss and rotator cuff status in failed anatomic shoulder arthroplasty after revision to reverse shoulder arthroplasty. J Shoulder Elbow Surg 2021;30:844-9. https://doi.org/10.1016/j.jse.2020.07.024
15. Frankle M, Siegal S, Pupello D, Saleem A, Mighell M, Vasey M. The reverse shoulder prosthesis for glenohumeral arthritis associated with severe rotator cuff deficiency. A minimum two-year follow-up study of sixty patients. J Bone Joint Surg Am 2005;87:1697-705. https://doi.org/10.2106/JBJS.D.02813
16. Frankle MA, Teramoto A, Luo Z-P, Levy JC, Pupello D. Glenoid morphology in reverse shoulder arthroplasty: classification and surgical implications. J Shoulder Elbow Surg 2009;18:874-85. https://doi.org/10.1016/j.jse.2009.02.013
17. Gauci M-O, Cavalier M, Gonzalez JF, Holzer N, Baring T, Walch G, et al. Revision of failed shoulder arthroplasty: epidemiology, etiology, and surgical options. J Shoulder Elbow Surg 2020;29:541-9. https://doi.org/10.1016/j.jse.2019.07.034
18. Gutiérrez S, Greiwe RM, Frankle MA, Siegal S, Lee WE 3rd. Biomechanical comparison of component position and hardware failure in the reverse shoulder prosthesis. J Shoulder Elbow Surg 2007; 16:S9-12. https://doi.org/10.1016/j.jse.2005.11.008
19. Harman M, Frankle M, Vasey M, Banks S. Initial glenoid component fixation in "reverse" total shoulder arthroplasty: a biomechanical evaluation. J Shoulder Elbow Surg 2005;14:162S-7S. https://doi.org/10.1016/j.jse.2004.09.030
20. Heifner JJ, Kumar AD, Wagner ER. Reverse shoulder arthroplasty used for revision of reverse shoulder arthroplasty: a systematic review. JSES Rev Rep Tech 2021;1:329-34. https://doi.org/10.1016/j.xrrt.2021.07.002
21. Holcomb JO, Cuff D, Petersen SA, Pupello DR, Frankle MA. Revision reverse shoulder arthroplasty for glenoid baseplate failure after primary reverse shoulder arthroplasty. J Shoulder Elbow Surg 2009;18: 717-23. https://doi.org/10.1016/j.jse.2008.11.017
22. Kelly JD 2nd, Zhao JX, Hobgood ER, Norris TR. Clinical results of revision shoulder arthroplasty using the reverse prosthesis. J Shoulder Elbow Surg 2012;21:1516-25. https://doi.org/10.1016/j.jse.2011.11.021
23. Nigro PT, Gutiérrez S, Frankle MA. Improving glenoid-side load sharing in a virtual reverse shoulder arthroplasty model. J Shoulder Elbow Surg 2013;22:954-62. https://doi.org/10.1016/j.jse.2012.10.025
24. Rojas J, Choi K, Joseph J, Srikumaran U, McFarland EG. Aseptic glenoid baseplate loosening after reverse total shoulder arthroplasty: a systematic review and Meta-analysis. JBJS Rev 2019;7:e7. https://doi.org/10.2106/JBJS.RVW.18.00132
25. Shields E, Wiater JM. Patient outcomes after revision of anatomic total shoulder arthroplasty to reverse shoulder arthroplasty for rotator cuff failure or component loosening: a matched cohort study. J Am Adad Orthop Surg 2019;27:e193-8. https://doi.org/10.5435/JAAOS-D-17-00350
26. Somerson JS, Hsu JE, Neradilek MB, Matsen FA 3rd. Analysis of 4063 complications of shoulder arthroplasty reported to the US Food and Drug Administration from 2012 to 2016. J Shoulder Elbow Surg 2018;27:1978-86. https://doi.org/10.1016/j.jse.2018.03.025
27. Wagner ER, Hevesi M, Houdek MT, Cofield RH, Sperling JW, Sanchez-Sotelo J. Can a reverse shoulder arthroplasty be used to revise a failed primary reverse shoulder arthroplasty?: Revision reverse shoulder arthroplasty for failed reverse prosthesis. Bone Joint J 2018; 100-B:1493-8. https://doi.org/10.1302/0301-620X.100B11.BJJ-2018-0226.R2
28. Wagner E, Houdek MT, Griffith T, Elhassan BT, Sanchez-Sotelo J, Sperling JW, et al. Glenoid bone-grafting in revision to a reverse total shoulder arthroplasty. J Bone Joint Surg Am 2015;97:1653-60. https://doi.org/10.2106/JBJS.N.00732
29. Wall B, Nové-Josserand L, O'Connor DP, Edwards TB, Walch G. Reverse total shoulder arthroplasty: a review of results according to etiology. J Bone Joint Surg Am 2007;89:1476-85. https://doi.org/10.2106/JBJS.F.00666
30. Zumstein MA, Pinedo M, Old J, Boileau P. Problems, complications, reoperations, and revisions in reverse total shoulder arthroplasty: a systematic review. J Shoulder Elbow Surg 2011;20:146-57. https://doi.org/10.1016/j.jse.2010.08.001