Failed Reverse Total Shoulder Arthroplasty: What Are Our Bailouts?

Brandon J. Erickson¹

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Abstract

Purpose of Review As the population continues to age and indications continue to expand, the number of reverse total shoulder arthroplasty (RTSA) procedures has increased significantly. While RTSA is an effective solution to many shoulder problems, it is not without complications. Furthermore, as the number of RTSA procedures increases, so will the number of complications following this procedure. While some complications can be managed with revision RTSA, there are some complications that, unfortunately, cannot. The purpose of this review is to discuss the revision options for failed RTSA.

Recent Findings While there has been a significant amount of recent literature surrounding RTSA, much of this literature has been aimed at improving outcomes for primary RTSA by improving glenoid placement, maximizing range of motion, etc., or improving outcomes following conversion of another surgery to RTSA [1•, 2, 3]. There has been little evidence surrounding options for failed RTSA that cannot be salvaged to a revision RTSA. These options are limited and often involve resection arthroplasty and hemiarthroplasty, although neither option provides patients with significant function of the shoulder [4, 5•].

Summary Complications following RTSA are becoming more common as the number of RTSA continues to increase. Furthermore, as the indications for RTSA expand, the complications will continue to increase as this implant is used to tackle more difficult problems about the shoulder. When possible, the etiology of the problem with the RTSA should be addressed and may involve component revision, bone grafting, etc. When the problem cannot be solved with revision RTSA, then the patient can be converted to a hemiarthroplasty, or have a resection arthroplasty, with the understanding that their shoulder function will be limited.

Keywords Reverse total shoulder arthroplasty (RTSA); Revision; Shoulder; Fusion; Hemiarthroplasty; Patient-specific instrumentation (PSI)

Introduction

The number of reverse total shoulder arthroplasty (RTSA) procedures has continued to increase each year [6, 7]. This increase is in part because of an aging population but also because of the expanding indications for RTSA [8]. As the population continues to age and live longer, there will be more and more patients who undergo primary RTSA, as well as more patients who undergo conversion to RTSA for failed anatomic total shoulder arthroplasty (TSA) or hemiarthroplasty, often

secondary to rotator cuff failure [2, 9]. Similarly, as the number of primary and revision to RTSA increases, the number of complications following RTSA will increase as well [10]. Unfortunately, dealing with a patient who has a failed RTSA can be a significant challenge for the treating orthopedic surgeon. This review will discuss the different causes of failure following RTSA as well as the treatment options for patients with a failed RTSA.

Causes of Failure Following RTSA

There are many causes of failure following RTSA including instability, nerve injury, baseplate failure, humeral sided failure, impingement of the components, infection, and others [11]. The most common causes of revision surgery in decreasing order of prevalence following RTSA are instability (38%), infection (22%), humeral problems (21%), and glenoid

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✉ Brandon J. Erickson
brandon.erickson@rothmanortho.com

¹ Rothman Orthopaedic Institute, 645 Madison Ave, New York, NY 10022, USA

loosening (13%) [12–14]. Many of these complications can be managed by correcting the etiology of the problem and can provide the patient with a suitable outcome. While the goal is to always provide the patient with as good of a functioning shoulder as possible, some of the salvage procedures become a limited goal operation.

Instability

One of the more common complications and causes of failure following RTSA is instability [15, 16]. There is a balance that needs to be achieved when placing RTSA components in place as one does not want to overstuff the shoulder, and this can lead to pain, loss of motion, etc., but leaving the shoulder too loose can be a cause of instability. Proximal bone loss and medialization of the glenoid can also contribute to instability after RTSA as the proper tension is not placed on the deltoid which can allow the component to dislocate. Mistakenly leaving a piece of the greater tuberosity posteriorly in the setting of a RTSA for a proximal humerus fracture can also contribute to instability as the humeral component can be levered out of place [17]. Finally, component malpositioning where the glenosphere is excessively anteverted, retroverted, or superiorly inclined can place the patient at risk for instability [18].

There are several options for correcting instability following RTSA, and which option to choose depends on the etiology of the instability. If a patient develops persistent instability following RTSA (Figure 1A–C) despite a closed reduction (Figure 2A–C) and conservative without a nerve injury, without any significant proximal bone loss, without malpositioned

Fig. 2 Axillary fluoroscopic (A and B) radiographs taken during reduction of the shoulder prosthesis confirming reduction and a final anteroposterior radiographs demonstrating the reduced prosthesis (C)

components, and without a piece of the greater tuberosity causing impingement, then the most likely scenario is that the shoulder was put in too loose or the patient has certain comorbidities such as morbid obesity that continued to the dislocation. This can be rectified by increasing the size of the glenosphere, increasing the amount of lateralization on the glenoid or humeral side depending on the type of implant system, and increasing the amount of distalization on the humeral

Fig. 1 Anteroposterior (A) and axillary (B and C) radiographs demonstrating a dislocation of a reverse shoulder arthroplasty (RTSA) in a morbidly obese patient who was treated with a RTSA for a symptomatic nonunion of a proximal humerus fracture

side (Figure 3A–B). This will restore the proper tension to the deltoid and provide stability to the implant. Unfortunately, most cases of instability involve something other than a shoulder that was put in too loose.

In the setting of instability secondary to malpositioned components, a revision RTSA can be performed to correct implant positioning, although great care must be taken to preserve proximal humeral bone stock and glenoid bone stock to assure the new components will have good fixation. Many implant systems now have glenoid augments that can be used to account for bone loss on the glenoid side and can help correct implant positioning (Figure 4). If the instability is secondary to a piece of greater tuberosity that escaped despite fixation when performing a RTSA for fracture, this piece can be removed, and the glenosphere size can be increased to aid in stability. If the instability is secondary to proximal humeral bone loss, this becomes a more complicated issue (Figure 5A). The surgeon should obtain bilateral views of the patient's arms to understand what their normal arm length is and how short the RTSA side with the instability is.

Once this is determined, a revision RTSA with use of proximal humeral allograft prosthetic composite (APC) graft can be performed to build up the humeral side back to the appropriate length. Obtaining a whole humerus allograft can allow the surgeon to properly measure and cut and will ensure enough length for the allograft. When using the proximal humeral allograft, sharply remove all of the rotator cuff tendons from the allograft piece, perform the humeral head cut in about 30° of retroversion, and begin to prepare the humeral shaft for your humeral component. Cut the allograft piece so that it has a shingle shape step cut with the lateral aspect of the allograft significantly longer than the medial aspect. The lateral aspect will sit outside the native bone, and the medial aspect will sit flush with the native bone. With the trial component in place within the allograft component, place the trial component down into the native humeral shaft, adjusting the cuts on the allograft piece so this sits flush. Then use 2–3 FiberTape Cerclage (Arthrex, Naples FL) to cerclage the allograft and native bone together. Remove the trial implant, and place the

Fig. 4 Grashey radiograph demonstrating use of a 20° augmented glenoid component. This particular patient had significant bone loss posterosuperiorly, and so the augmented glenoid MGS baseplate (Arthrex, Naples FL) was used to correct this and obtain proper implant positioning with a slight inferior tilt. Not accounting for this can lead to inadvertent superior tilt to the baseplate and can be a setup for failure.

real humeral stem in place. If there is any stem exposed medially, place a piece of allograft bone here and cerclage this in place (Figure 5B). Reduce the shoulder, and ensure this is stable throughout a course of range of motion (ROM) (Figure 5C–D) [19]. Cox et al reported the results of 73 patients treated with a proximal humerus APC over a span of 10 years [20••]. The authors found significant improvements in all clinical outcome scores at an average of 68-month follow-up, although the average final score on the American Shoulder and Elbow Surgeons (ASES) score was only 51.4. Interestingly, 70% of patients achieved good or excellent results, and 19% of patients required revision surgery for periprosthetic fracture ($n = 6$), instability ($n = 2$), glenosphere dissociation ($n = 2$), humeral loosening ($n = 2$), and infection ($n = 2$) at an average of 38 months postoperatively.

Fig. 3 3-month postoperative anteroposterior (A) and axillary (B) radiograph after revision reverse shoulder arthroplasty to a larger glenosphere and increased lateralization

Fig. 5 Preoperative anteroposterior image (A) demonstrating a significant amount of proximal humeral bone loss in a patient with persistent instability. Intraoperative image (B) demonstrating use of a proximal humerus allograft prosthetic composite (APC) for a patient with significant proximal humeral bone loss and persistent instability. Six-month postoperative anteroposterior (C) and axillary (D) radiographs demonstrating the use of the proximal humeral APC with no evidence of instability. The patient is slightly rotated, so one must follow the line of the supraspinatus fossa to see the true inclination of the glenosphere

Glenoid Bone Loss

Bone loss of the glenoid side of a RTSA in the setting of a failed baseplate can be one of the most difficult problems of the shoulder to tackle. Unfortunately, there is simply not much bone stock on the glenoid, so dealing with large glenoid defects presents a uniquely challenging problem. When a glenoid baseplate has failed in the setting of a RTSA and the surgeon is concerned about glenoid bone stock, there are a few options for revising this. The first step is to obtain advanced imaging, typically in the form of a computed tomography (CT) scan with metal subtraction to understand how significant the bone loss is. Sometimes the CT scan can be useful, but often the metal from the components obscures the surgeon's ability to adequately assess the bone loss. However, this can help the surgeon to get a feel for the bone loss and determine if bone grafting and a single stage revision are possible or if other options must be considered. The surgeon should be prepared for multiple scenarios including glenoid bone grafting with allograft and resection of the components. When the patient is taken to the operating room, the glenoid component is removed, and the bone loss is assessed. If the surgeon feels there is good peripheral bone stock and the defect is mostly central, then the central defect can often be grafted, and a revision component can be placed in a single stage procedure. If the

defect is on the periphery of the glenoid and there is no bone stock for fixation for the implant, bone graft can be placed for later salvage, or the component can be removed. Once the component is removed and the patient has recovered, a CT scan can then be obtained to assess the glenoid defect. This can then be used to create a 3D patient-matched glenoid component that is printed specifically for that patient's anatomy and can be used to obtain secure fixation on the glenoid despite significant bone loss (Vault Reconstruction System (VRS), Zimmer Biomet, Warsaw, IN).

If this implant does not work or is not feasible, the patient can be converted to a hemiarthroplasty or can undergo a resection arthroplasty as a salvage option [4, 5•]. Gauci et al reported the outcomes following revision of RTSA in 81 patients for failed RTSA over the course of 10 years [21]. The reason for revision RTSA was most commonly instability (32%), infection (24%), and glenoid component loosening (24%) with humeral sided problems much less common (10%). Of the 81 patients who underwent revision RTSA, 75% of these patients were revised to another RTSA, while 25% were revised to a salvage procedure. Of these 25% of patients revised to something other than a RTSA, 10% were revised to a hemiarthroplasty (all of which were done for glenoid loosening), and 15% were revised to a permanent antibiotic spacer or resection arthroplasty (92% of which

underwent this for infection, while 8% underwent when this for persistent instability).

Glanzmann et al reported the results of 16 patients who underwent revision of a RTSA to a hemiarthroplasty secondary to inadequate glenoid bone stock [22]. The reason for revision was glenoid loosening in 69% of patients. The results demonstrated poor functional outcome with mean constant score of 25, a mean Shoulder Pain and Disability Index of 37, and mean 11-item version of the Disabilities of the Arm, Shoulder and Hand scores of 63. Unfortunately, baseline pain did not reliably improve in these patients. Furthermore, 6 patients experienced progression of medialization beyond the coracoid, and 3 patients suffered from complete anterosuperior escape.

Muh et al reported the results of 26 patients at 5 different institutions who underwent resection arthroplasty for failed shoulder arthroplasty at an average of 41.7 months [23]. Of this cohort, 13 patients had a RTSA in place before the resection arthroplasty, and the majority of the resections were performed for infection. At final follow-up, the authors found an average visual analog scale (VAS) pain score of 3.3, an average ASES score of 38.3, and an average constant shoulder score of 26.8. In regard to ROM, the average forward flexion was 32.7°, while the average external rotation was 6.5°. Hence, these results suggest that resection arthroplasty can lead to improvements in pain but also lead to limitations in function.

Conclusion

Complications following RTSA are becoming more common as the number of RTSA continues to increase. Furthermore, as the indications for RTSA expand, the complications will continue to increase as this implant is used to tackle more difficult problems about the shoulder. When possible, the etiology of the problem with the RTSA should be addressed and may involve component revision, bone grafting, etc. When the problem cannot be solved with revision RTSA, then the patient can be converted to a hemiarthroplasty, or have a resection arthroplasty, with the understanding that their shoulder function will be limited.

Declarations

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

Conflict of Interest AAOS: Board or committee member American Orthopaedic Society for Sports Medicine: Board or committee member American Shoulder and Elbow Surgeons: Board or committee member Arthrex, Inc: Paid consultant; Research support DePuy, A Johnson &

Johnson Company: Research support Linvatec: Research support PLOS One: Editorial or governing board Smith & Nephew: Research support Stryker: Research support.

References

Papers of particular interest, published recently, have been highlighted as:

- Of importance
- Of major importance

- 1.•• Erickson BJ, Chalmers PN, Denard P, Lederman E, Homeff G, Werner BC, et al. Does commercially available shoulder arthroplasty preoperative planning software agree with surgeon measurements of version, inclination and subluxation? *Journal of shoulder and elbow surgery / American Shoulder and Elbow Surgeons et al.* 2020. **This study demonstrates the difference in preoperative planning software between manufacturers. It also shows that many of these commercially available softwares produce measurements of version and inclination similar to that of surgeons**
2. Harrison AK, Knudsen ML, Braman JP. Hemiarthroplasty and total shoulder arthroplasty conversion to reverse total shoulder arthroplasty. *Curr Rev Musculoskelet Med.* 2020;13(4):501–8.
3. Crosby LA, Wright TW, Yu S, Zuckerman JD. Conversion to reverse total shoulder arthroplasty with and without humeral stem retention: the role of a convertible-platform stem. *J Bone Joint Surg Am.* 2017;99(9):736–42.
4. Gamradt SC, Gelber J, Zhang AL. Shoulder function and pain level after revision of failed reverse shoulder replacement to hemiarthroplasty. *Int J Shoulder Surg.* 2012;6(2):29–35.
- 5.• Song IS, Jung D, Jeong U, An CH. Conversion of failed reverse total shoulder arthroplasty to hemiarthroplasty: three cases of instability and three cases of glenoid loosening. *Clin Orthop Surg.* 2019;11(4):436–44 **This study highlights the results following conversion or RTSA to hemiarthroplasty. This is a very difficult problem, and as such the results are often less than optimal.**
6. Erickson BJ, Bohl DD, Cole BJ, Verma NN, Nicholson G, Romeo AA, et al. Reverse total shoulder arthroplasty: indications and techniques across the world. *Am J Orthop.* 2018;47(9).
7. Gupta AK, Harris JD, Erickson BJ, Abrams GD, Bruce B, McCormick F, et al. Surgical management of complex proximal humerus fractures -a systematic review of 92 studies including 4, 500 patients. *J Orthop Trauma.* 2014.
8. Mechlenburg I, Rasmussen S, Unbehaun D, Amundsen A, Rasmussen JV. Patients undergoing shoulder arthroplasty for failed nonoperative treatment of proximal humerus fracture have low implant survival and low patient-reported outcomes: 837 cases from the Danish Shoulder Arthroplasty Registry. *Acta Orthop.* 2020;91(3):319–25.
9. Erickson BJ, Ling D, Wong A, Eno JJ, Dines JS, Dines DM, et al. Does having a rotator cuff repair prior to reverse total shoulder arthroplasty influence the outcome? *Bone Jt J.* 2019;101-B(1):63–7.
10. 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. *Journal of Shoulder and Elbow Surgery / American Shoulder and Elbow Surgeons [et al].* 2021;30(4):844–9.

11. Tashjian RZ, Granger E, Broschinsky K, Kawakami J, Chalmers PN. Effect of complications on outcomes after revision reverse total shoulder arthroplasty. *JSES Int*. 2020;4(3):662–8.
12. Coste JS, Reig S, Trojani C, Berg M, Walch G, Boileau P. The management of infection in arthroplasty of the shoulder. *J Bone Joint Surg Br*. 2004;86(1):65–9.
13. Zumstein MA, Pinedo M, Old J, Boileau P. Problems, complications, reoperations, and revisions in reverse total shoulder arthroplasty: a systematic review. *Journal of shoulder and elbow surgery / American Shoulder and Elbow Surgeons [et al]*. 2011;20(1):146–57.
14. Keener JD, Chalmers PN, Yamaguchi K. The humeral implant in shoulder arthroplasty. *J Am Acad Orthop Surg*. 2017;25(6):427–38.
15. Erickson BJ, Frank RM, Harris JD, Mall N, Romeo AA. The influence of humeral head inclination in reverse total shoulder arthroplasty: a systematic review. *Journal of shoulder and elbow surgery / American Shoulder and Elbow Surgeons [et al]*. 2015.
16. Chae J, Siljander M, Wiater JM. Instability in reverse total shoulder arthroplasty. *J Am Acad Orthop Surg*. 2018;26(17):587–96.
17. Erickson BJ, Shishani Y, Bishop ME, Romeo AA, Lederman E, Gobeze R. Tuberosity repair in reverse total shoulder arthroplasty for fracture using a stem-based double-row repair: a cadaveric biomechanical study. *J Am Acad Orthop Surg*. 2020.
18. Black EM, Roberts SM, Siegel E, Yannopoulos P, Higgins LD, Warner JJ. Failure after reverse total shoulder arthroplasty: what is the success of component revision? *Journal of shoulder and elbow surgery / American Shoulder and Elbow Surgeons [et al]*. 2015;24(12):1908–14.
19. Sanchez-Sotelo J, Wagner ER, Houdek MT. Allograft-prosthetic composite reconstruction for massive proximal humeral bone loss in reverse shoulder arthroplasty. *JBJS Essent Surg Tech*. 2018;8(1):e3.
20. Cox JL, PB ML, Christmas KN, Simon P, Mighell MA, Frankle MA. Clinical outcomes following reverse shoulder arthroplasty-allograft composite for revision of failed arthroplasty associated with proximal humeral bone deficiency: 2- to 15-year follow-up. *Journal of shoulder and elbow surgery / American Shoulder and Elbow Surgeons [et al]*. 2019;28(5):900–7 **This study shows the mid to long term results following a proximal humeral APC for failed shoulder arthroplasties. Considering the difficult situation these patients were in, their outcomes were reasonable, albeit not as good as primary shoulder arthroplasty.**
21. Gauci MO, Cavalier M, Gonzalez JF, Holzer N, Baring T, Walch G, et al. Revision of failed shoulder arthroplasty: epidemiology, etiology, and surgical options. *Journal of shoulder and elbow surgery / American Shoulder and Elbow Surgeons [et al]*. 2020;29(3):541–9.
22. Glanzmann MC, Kolling C, Schwyzer HK, Audige L. Conversion to hemiarthroplasty as a salvage procedure for failed reverse shoulder arthroplasty. *Journal of shoulder and elbow surgery / American Shoulder and Elbow Surgeons [et al]*. 2016;25(11):1795–802.
23. Muh SJ, Streit JJ, Lenarz CJ, McCrum C, Wanner JP, Shishani Y, et al. Resection arthroplasty for failed shoulder arthroplasty. *Journal of shoulder and elbow surgery / American Shoulder and Elbow Surgeons [et al]*. 2013;22(2):247–52.

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