Hemiarthroplasty and Total Shoulder Arthroplasty Conversion to Reverse Total Shoulder Arthroplasty

Alicia K. Harrison¹ · Michael L. Knudsen¹ · Jonathan P. Braman¹

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Abstract

Purpose of Review The incidence of shoulder arthroplasty is increasing dramatically for primary arthroplasty but also for revision arthroplasty. Revision to reverse total shoulder arthroplasty is increasingly the salvage operation for failed primary arthroplasty. The purpose of this review is to explore the indications for and results of revision reverse total shoulder arthroplasty.

Recent Findings Despite relatively high complication and reoperation rates with revision shoulder replacement, revision of failed hemiarthroplasty or total shoulder arthroplasty to reverse total shoulder arthroplasty improves outcomes for many patients. A failed hemiarthroplasty or total shoulder arthroplasty is frequently disabling for the patient and because the surgical revision options are often limited only to reverse total shoulder arthroplasty, the potential improvement is often worth the higher surgical complication or reoperation rate.

Summary Due to the challenges inherent in revision arthroplasty, revision of primary arthroplasty to reverse total shoulder arthroplasty, outcomes are poorer than primary reverse total shoulder arthroplasty. Despite these limitations, patient postoperative pain and function do increase from preoperative levels making conversion of hemiarthroplasty or anatomic total shoulder to reverse total shoulder arthroplasty an important option for a challenging problem.

Keywords Shoulder arthroplasty · Revision shoulder arthroplasty · Reverse total shoulder arthroplasty · Complex shoulder revision

Introduction

The incidence of primary shoulder arthroplasty has increased significantly in recent decades, with a 2.5-fold increase from 1998 to 2008 in the USA [1]. Finland saw a 160% increase in the incidence of primary shoulder arthroplasty from 2004 to 2015 with a 500% increase in anatomic total shoulder arthroplasty (aTSA) and a 4500% increase in reverse total shoulder arthroplasty (rTSA) over that same time period

[2•]. With the increase in primary shoulder arthroplasty, the number of shoulder arthroplasty revisions increased as well [3••]. Although failed hemiarthroplasty (HA) or aTSA can be revised to another aTSA, the workhorse of revision shoulder arthroplasty has been the rTSA. One group reported on their experience with revision shoulder arthroplasty from 2005 to 2016 and found that the number of revisions involving the rTSA increased from 51% in 2005–2010 to 78% in 2011–2016 [3••]. Published studies have already outlined the improvement in pain and function in failed HA or aTSA converted to rTSA, but many studies also highlight the relatively higher complication and reoperation rate with these conversions [4–20]. This article serves to highlight the most recent literature on conversion to rTSA.

This article is part of the Topical Collection on *Reverse Shoulder Arthroplasty*

✉ Alicia K. Harrison
harri736@umn.edu

Michael L. Knudsen
knudsen@umn.edu

Jonathan P. Braman
brama011@umn.edu

¹ Department of Orthopaedic Surgery, University of Minnesota, Minneapolis, MN, USA

Failed Shoulder Arthroplasty: Etiologies and Indications for Revision

Anatomic TSA has enjoyed a historically high rate of patient satisfaction, clinical outcomes, and implant survivorship [21, 22]. Anatomic total shoulder arthroplasty provides more

predictable pain relief and range of motion compared with HA [21]. HA may be indicated for proximal humerus fracture, humeral avascular necrosis, glenohumeral arthrosis in a young active individual, or cuff tear arthropathy in a very young patient. Although both HA and aTSA can perform well for quite some time, there are a number of etiologies that can lead to conversion to rTSA. Glenoid arthrosis, aseptic glenoid component loosening, rotator cuff failure, or infection are all indications for HA or aTSA conversion to rTSA. Many have noted that outcomes for revision shoulder arthroplasty depend on the reason for revision; revisions for component loosening or glenoid wear have better outcomes than those done for infection or instability [23, 24].

Rarely HA or aTSA may be revised to another aTSA though these cases are less common. Such a case would require a functional rotator cuff and adequate glenoid bone stock, and as with many revisions may be associated with a higher complication rate [25•]. Sheth et al. reported on a series of patients undergoing conversion from HA to aTSA for glenoid arthrosis and identified 93% and 86% implant survival at 2 and 5 years respectively but also noted a 36% complication rate and 21% reoperation rate [25••].

Evaluating the Failed Shoulder Arthroplasty

Unfortunately, evaluation of the painful shoulder arthroplasty can be challenging. Clear radiographic signs of loosening may be seen in some cases as evidenced by lucency around the glenoid or humeral component or by a change in implant position (Figs. 1 and 2a, b). More often, however, a painful shoulder arthroplasty may have no clear radiographic loosening and serologic testing for infection is often negative in infected shoulder arthroplasty [26]. Basic radiologic workup must include AP, Grashey, scapular Y, and axillary radiographs to evaluate for loosening. It must be recognized that humeral stem loosening is associated with a higher risk of prosthetic joint infection [27]. Computed tomography (CT) arthrogram or diagnostic ultrasound may be useful to evaluate the integrity of the rotator cuff in a painful or dysfunctional HA or anatomic TSA [28]. CT imaging may also assist in further evaluating peri-implant lucencies or signs of loosening around the implants. Laboratory evaluation for infected shoulder arthroplasty should include basic serologies (CBC with diff, ESR, CRP) but may include synovial IL-7 which has shown promise in the diagnosis of infected shoulder arthroplasty [29, 30]. Definitive diagnosis of infected shoulder arthroplasty involves arthroscopic biopsy to include 5 separate tissue specimens with anaerobic cultures to be kept for at least 2 weeks to rule out *Cutibacterium acnes* which is a slow-growing fastidious anaerobe [31, 32].

Fig. 1 Lateral view of this reverse total shoulder arthroplasty demonstrates lucency around the humeral stem tip. This stem was frankly loose at the time of revision

Technical Considerations of Revision Reverse TSA

Conversion of failed HA or aTSA is not often a straightforward surgical procedure. The complexity of the conversion is dependent on many factors including existing component loosening, cemented or uncemented components, presence of any prior allograft composites, and the bone or soft tissue deficiencies from either implant wear or prior surgeries. In our experience, uncemented components are typically converted more easily than cemented components. Patient history of a high number of prior surgical procedures also increases the complexity due to soft tissue alterations.

The surgeon must be facile and comfortable with more extensive soft tissue releases to safely mobilize the humerus and expose the glenoid in converting a prior arthroplasty to rTSA. Failure to complete these releases prevents the appropriate positioning of the humerus during humeral implant removal. If the humerus cannot be adequately externally rotated and adducted, the surgeon may not obtain the appropriate angle for removal of a well-fixed humeral stem, risking greater proximal humeral bone removal or periprosthetic humerus fracture. Additionally, mobilization around the humerus improves access to and visualization of the glenoid for glenoid implant removal and conversion to rTSA.

Fig. 2 **a, b** There is a change in the orientation of the glenoid radiopaque marker with the inferior tilt of the marker in the second image evidence of change in implant positioning or loosening

Outcomes of Conversion to Reverse TSA

As early as 2006, Boileau et al. described the utility of rTSA in revision arthroplasty [4]. Glenoid bone defects secondary to aTSA glenoid component removal, cuff failure or deficiency, and proximal humerus bone loss are challenges which may be addressed by the reverse design. Reverse total shoulder arthroplasty has therefore become the workhorse for revision shoulder arthroplasty and there is increasing evidence on outcomes and survivability of these conversions.

Many authors identify a relatively high complication or reoperation rate with revision shoulder replacement. A review of the literature published on HA or aTSA conversion to rTSA demonstrates a reported complication rate from 6 to 50% and a reoperation rate of 5–24% [5–20]. Despite this higher complication rate, a number of studies note a reasonable improvement in outcome measures or patient satisfaction. Sheth et al. reported on 73 patients with a minimum 2-year follow-up and found 70% of patients were “very satisfied” or “satisfied” and 22% were “dissatisfied” or “very dissatisfied.” [5•]. Mellis et al. and Kelly et al. reported 86% and 80% of patients in their series respectively were satisfied or very satisfied [17, 18]. Many series also found significant improvements in VAS pain score after conversion to rTSA [5, 9, 12–16].

Because a failed HA or aTSA is often a painful and debilitating problem for the patient and because the surgical revision options are often limited only to rTSA, the potential improvement is felt by most to be worth the higher surgical complication or reoperation rate. Shields and Wiater reported on their series of aTSA revised to rTSA solely for cuff failure or loosening and compared those to a matched cohort of primary rTSA. Despite comparable function, the revision rTSA cohort had more complications (31% vs 13%), and lower patient satisfaction (74% vs 90%) [6•]. Although attempts have been made to identify preoperative characteristics which may predict more successful postoperative outcomes, the vast

majority of published literature includes retrospective series which were unable to adequately study those risk factors.

Risk Modification within Reverse TSA Conversion

Several authors have evaluated their own series to determine if certain factors increase the complication rate or outcomes and several trends have been identified. Revision of the humeral stem is associated with measurably greater morbidity compared with cases where the humeral stem is retained. Sheth et al. identified the increased intraoperative morbidity with stem revision in their series with 27% requiring humeral corticotomy and 19% with intraoperative fractures [5•]. Others have found that humeral stem retention is associated with reduced operative time and blood loss [9, 11, 13].

One of the more common indications for the conversion of HA to rTSA is sequelae of HA for fracture. A number of published series include a significant number of these revisions. In a relatively older series [20], Levy et al. presented 29 patients revised for fracture sequelae. In their series with an average follow-up of 35 months, the average active forward elevation was only 73 and the average ASES score was 52. More recent series however have seen somewhat better results [5, 8, 33]. Holschen et al. reported average ASES of 59 and forward elevation to 104° at 61 months but their complication rate was 32% [8•].

One indication for revision felt to be at higher risk for complications or poorer outcomes is an infected arthroplasty. Although most authors’ series identified a trend toward poorer outcomes for patients revised with infection, Kim et al. reviewed their series by etiology for revision and found that conversion to rTSA for infection had the poorest clinical outcomes of any group [34•].

Fig. 3 Antibiotic spacer in place after shoulder arthroplasty explantation

Survivorship of Converted Reverse TSA

Although rTSA has grown exponentially since its introduction to the USA in 2004, long-term data on many of these conversions is still lacking. Implant survivorship of converted rTSA is reported by some authors but has varied from series to series. Cox et al. reported on their complex series of arthroplasties revised with an alloprosthetic rTSA component and identified 88% survival at 5 years and 78% at 10 years [7•]. Sheth et al. found 74% survival at 5 years [5••].

Authors' Preferred Surgical Management of Conversion to Reverse TSA

We advocate for use of the deltopectoral approach in primary but especially in revision shoulder arthroplasty. We strongly advise against the anterosuperior deltoid-splitting approach as it is not extensile and the axillary nerve is at much greater risk for injury. We perform thorough releases of the subdeltoid and subacromial space to allow more improved humeral mobility

and access to the humeral canal and glenoid. We perform a subscapularis peel where the subscapularis remains or subperiosteal capsular release if the subscapularis is absent or deficient. In cases of significant scar formation, particularly infected cases, more extensile medial subperiosteal dissection or releases are needed.

If the humeral stem must be revised, we utilize flexible osteotomes, stem extractors, and slap hammers or offset drift tools to apply force on the stem in line with the canal. The stem should not be struck at a significant angle to the humerus as this risks fracture or increased bone loss. This approach requires maximum adduction and external rotation of the arm. In cases where the stem is well cemented or has extensive ingrowth, a vertical humerus osteotomy may be necessary. A controlled corticotomy can be created with small drill holes in line vertically connected by an osteotome or a thinly bladed micro sagittal saw [35].

In cases of confirmed or suspected infection (or if a two-stage revision is anticipated due to glenoid bone loss), we utilize an antibiotic spacer created intraoperatively on the back table using a size-specific silicone mold (Fig. 3). The distal-most tip of the spacer should be colored with a surgical marker. This allows visual confirmation that the spacer did not fracture during removal and allows the surgeon to confirm the complete removal of the spacer at the next stage.

Adequate glenoid exposure requires capsular releases and these are always done with the position of the axillary nerve in mind. We protect the nerve using the tug test [36] and we request our anesthesia colleagues administer no muscle paralysis in order to allow for the nerve to stimulate deltoid contraction if stimulated during surgery. In the case of extreme stiffness during some rare and more complex revisions, the surgeon may need to perform deltoid takedown or coracoid osteotomy for additional exposure of the shoulder [37]. While these are rare in our practice, both are useful to learn and worth practicing in the cadaver lab so that they are within a surgeon's skill set when needed.

Fig. 4 **a** Total shoulder arthroplasty performed over 20 years prior to trauma. Lucency around cemented glenoid consistent with loosening. **b** Patient with an antibiotic spacer in place. Note the corticotomy necessary for removal of a well-cemented long humeral stem. Also, note lucency in glenoid secondary to a large area of bone loss. **c** Patient CT after total

shoulder arthroplasty explantation and placement of antibiotic spacer. Note the large amount of bone loss in the glenoid vault and rim. **d** Patient after revision to reverse total shoulder arthroplasty with patient-specific glenoid implant to address glenoid bone loss

If glenoid bone defects are present, we address these either with an augmented baseplate or, in cases of extreme bone loss, a patient-specific implant based on preoperative CT with parameters based on the manufacturer's protocol (Figs. 4a–d). Although reverse TSA lends itself to glenoid bone grafting, we avoid allograft for concerns of adequate bone incorporation and autograft or allograft in cases of confirmed or suspected infection.

Revision to a new humeral stem is completed with a shorter stem if proximal humeral bone quality allows. If there is measurable proximal humerus bone loss, we use a longer stem, adding cement if needed. In more extreme cases of humeral bone loss, a tumor style prosthesis system may be used. Tensioning in a revision rTSA can be challenging and we assess factors such as difficulty or ease of reduction, implant “shuck,” conjoint tendon and axillary nerve tension, and instability with the application of lateral force on the proximal humerus.

After placement of all final components, we often place two medium-size drains given the increased risk of bleeding in revision shoulder arthroplasty and the open space around the joint created in rTSA. The subscapularis is often not present or of sufficient quality so it is not repaired. Postoperatively, the patient remains in an abduction sling for 6 weeks allowing only hand, wrist, and gentle elbow motion. Shoulder motion is initiated at 6 weeks with active assisted and active motion as tolerated. The overall functional goals are limited in many but not all of these patients, and the postoperative plan for therapy is targeted to the goals and anatomic deficiencies of the patient.

Conclusions

The increasing incidence of primary shoulder arthroplasty has also been accompanied by an increasing incidence of revision shoulder arthroplasty. The vast majority of shoulder arthroplasty revisions involve a reverse TSA design. These are challenging cases with higher complication rates and reoperation rates. Though outcomes are poorer than is seen in primary rTSA, patient postoperative pain and function have been found to increase above preoperative levels making conversion of HA or aTSA to rTSA an important option for a challenging problem.

Compliance with Ethical Standards

Conflict of Interest Alicia Harrison has received a grant from Zimmer Biomet and has received speaker honorarium from Arthrex, Inc. Michael Knudsen declares that he has no conflict of interest. Jonathan Braman is a consultant for Zimmer Biomet.

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.

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- Of major importance

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2. Harjula JNE, Paloneva J, Haapakoski J, Kukkonen J, Äärimaa V. Finnish Shoulder Arthroplasty Registry Group. Increasing incidence of primary shoulder arthroplasty in Finland - a nationwide registry study. *BMC Musculoskelet Disord*. 2018;19(1):245. <https://doi.org/10.1186/s12891-018-2150-3> **The purpose of this study was to investigate the incidence of primary shoulder arthroplasty in Finland. Methods: We analyzed nationwide data from the Finnish Arthroplasty Register (FAR) and the Finnish National Hospital Discharge Register (NHDR) during time period 2004–2015. The primary outcome variable was the incidence of shoulder arthroplasty per 100,000 person-years stratified by age, sex, and year of surgery. The secondary outcome variables were surgical indication, arthroplasty type, and prosthesis model. Results: The number of primary shoulder arthroplasties was 7504 (women = 4878, men = 2625). The rate of operations increased from 6 to 15 per 100,000 person-years among men, and 11 to 26 per 100,000 person-years among women. The indication for arthroplasty was osteoarthritis in 56%, acute fracture in 21%, inflammatory arthritis in 13%, and rotator cuff arthropathy in 4% of the cases. Hemiarthroplasties accounted for 66%, total shoulder arthroplasties 8%, and reverse shoulder arthroplasties 12% of the cases; 14% of the cases was missing. During the 12-year study period, the incidence of hemiarthroplasties decreased by 23% and the number of total shoulder and reverse shoulder arthroplasty increased by 500 and 4500%, respectively. Conclusions: The incidence of primary shoulder arthroplasty has increased by 160% during the study period in Finland. The incidence of hemiarthroplasties decreased while total and reverse shoulder arthroplasties increased.**
3. Wagner ER, Chang MJ, Welp KM, Solberg MJ, Hunt TJ, Woodmass JM, et al. The impact of the reverse prosthesis on revision shoulder arthroplasty: analysis of a high-volume shoulder practice. *J Shoulder Elbow Surg*. 2019;28(2):e49–56. <https://doi.org/10.1016/j.jse.2018.08.002> **Background: Since the approval of reverse shoulder arthroplasty (RSA) in 2004, the use of shoulder arthroplasty increased dramatically. Although the success of RSA in the revision setting has been demonstrated, there remains a paucity of studies examining the epidemiology of RSA in revision arthroplasty. This study describes trends of revision arthroplasty during the “era of the reverse,” from 2005 through 2016. Methods: In a multicenter retrospective analysis, we analyzed 274 revision shoulder arthroplasties converted to a RSA ($n = 182$), anatomic total shoulder arthroplasty (TSA, $n = 68$), or hemiarthroplasty ($n = 24$) from 2005 to 2016. Demographics, surgical indications, and types of prosthesis were analyzed. Results: The number of revision**

arthroplasties increased over 12 years. From 2005 to 2010, TSA (33%) or hemiarthroplasty (16%) was used in similar rates as RSA (51%). From 2011 to 2016, there was a much higher incidence of revision arthroplasty with RSA (78%) compared with TSA (19%) or hemiarthroplasty (3%). Specifically, the number of RSAs increased in 2011 to 2016 compared with 2005 to 2010 in patients aged younger than 60 years, obese patients, patients with indications of glenoid loosening, and those with a diagnosis of diabetes mellitus or rheumatoid arthritis. **Conclusions:** The use of RSA for revision arthroplasty increased over the “era of the reverse” and became the majority by 2016. The reverse prosthesis has had expanding indications regarding both patient demographics and pathology. **This study demonstrates the reverse prosthesis has had a similar and even more profound effect on revision shoulder arthroplasty than what has previously been well documented in the primary setting.**

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5. Sheth MM, Sholder D, Getz CL, Williams GR, Namdari S. Revision of failed hemiarthroplasty and anatomic total shoulder arthroplasty to reverse total shoulder arthroplasty. *Shoulder Elbow Surg.* 2019;28(6):1074–81. <https://doi.org/10.1016/j.jse.2018.10.026> **Background:** The impending burden of revision shoulder arthroplasty has increased interest in outcomes of revision procedures. Revision of failed anatomic arthroplasty to reverse total shoulder arthroplasty has shown promise alongside concerning complication rates. **Methods:** Patients who underwent revision shoulder arthroplasty during a 7-year period at a tertiary care health system were identified. Presurgical and operative data were analyzed for 110 patients who met inclusion and exclusion criteria. Patients were contacted at a mean follow-up of 57 ± 26 months (range, 23–113 months) from revision surgery for functional outcomes scores, reoperations, and implant survival. **Results:** Implant survival was 92% at 2 years and 74% at 5 years. Mean American Shoulder and Elbow Surgeons score, Single Assessment Numerical Evaluation score, and visual analog scale pain scores were 63 ± 24 (range, 5–97), 60 ± 25 (range, 0–100), and 2.9 ± 2.9 (range, 0–10), respectively. Seventy percent of patients were “very satisfied” or “satisfied with their outcome.” Complications occurred in 18 patients (20%), and 10 patients (11%) underwent reoperation. **Conclusions:** Modest patient results and satisfaction can be achieved with revision of a failed anatomic arthroplasty to a reverse total shoulder arthroplasty. As is typical of revision surgery, complications are common and can compromise results. Further study is needed to identify factors that may contribute to successful outcomes.
6. 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 Acad Orthop Surg.* 2019;27(4):e193–8. <https://doi.org/10.5435/JAAOS-D-17-00350> **Purpose:** To compare outcomes after conversion of anatomic total shoulder arthroplasty (aTSA) to reverse total shoulder arthroplasty (RTSA) and a matched cohort. **Methods:** Patients converted from aTSA to RTSA for rotator cuff failure or component loosening and a primary RTSA matched cohort were retrospectively identified from a prospective database. Demographics and preoperative and postoperative outcomes were obtained and compared. **Results:** Age, sex, body mass index, follow-up length, and preoperative function were similar between revision ($n = 35$) and primary ($n = 70$) groups. At final follow-up, visual analog scale pain (2.4 ± 2.8 vs 1.7 ± 2.8 ; $P = 0.24$) and American Shoulder and Elbow Surgeons (68 ± 26 vs 76 ± 24 ; $P = 0.14$) scores were similar. The revision group had worse subjective shoulder value scores (63 ± 30 vs 79 ± 21 ; $P = 0.002$), satisfaction (74% vs 90%; $P = 0.03$), and more complications (31% vs 13%; $P = 0.02$). **Conclusion:** Revision of aTSA to RTSA for component loosening or rotator cuff failure results in function comparable with primary RTSA; however, more complications, worse subjective shoulder value scores, and lower patient satisfaction should be expected. **Level of Evidence:** Level III, retrospective comparative.
7. Cox JL, McLendon PB, 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. *J Shoulder Elbow Surg.* 2019;28(5):900–7. <https://doi.org/10.1016/j.jse.2018.10.023> **Background:** Patients with pain and disability due to a prior failed shoulder arthroplasty with associated proximal humeral bone loss have limited reconstruction options. Our purpose was to report the results of a large cohort of patients treated with a reverse shoulder allograft-prosthetic composite (APC). **Methods:** Between 2002 and 2012, a total of 73 patients were treated with a reverse shoulder APC and had adequate follow-up. Clinical outcome scores, range of motion, and radiographic evidence of failure were assessed. The minimum follow-up period was 2 years, with an average of 67.9 months (range, 21–157 months). Of the patients, 43 had more than 5 years’ follow-up and 12 had more than 10 years’ follow-up. **Results:** The total American Shoulder and Elbow Surgeons score improved from 33.8 to 51.4 ($P < .0001$), and the Simple Shoulder Test score improved from 1.3 to 3.5 ($P < .0001$). Good to excellent results were reported in 42 of 60 patients (70%), 10 patients (17%) reported satisfactory results, and 8 patients (13%) were unsatisfied. Range of motion improved in forward flexion (49 to 75° , $P < .001$) and abduction (45 to 72° , $P < .001$). Revision was required in 14 patients (19%) for periprosthetic fracture ($n = 6$), instability ($n = 2$), glenosphere dissociation ($n = 2$), humeral loosening ($n = 2$), and infection ($n = 2$) at a mean of 38 months postoperatively. The reoperation-free survival rate of all reconstructions was 88% (30 of 34) at 5 years, 78% (21 of 27) at 10 years, and 67% (8 of 12) beyond 10 years. Ten patients had radiographic evidence of humeral loosening at final follow-up, and 2 required revision. **Conclusions:** The use of a reverse total shoulder APC provides reliable pain relief and improved range of motion, with an acceptable rate of complications. Although ultimate function achieved is limited, patient satisfaction remains high.
8. Holschen M, Siemes MK, Witt KA, Steinbeck J. Five-year outcome after conversion of a hemiarthroplasty when used for the treatment of a proximal humeral fracture to a reverse total shoulder arthroplasty. *Bone Joint J.* 2018;100-B(6):761–6. <https://doi.org/10.1302/0301-620X.100B6.BJJ-2017-1280.R1> **Aims:** The reasons for failure of a hemiarthroplasty (HA) when used to treat a proximal humeral fracture include displaced or necrotic tuberosities, insufficient metaphyseal bone-stock, and rotator cuff tears. Reverse total shoulder arthroplasty (rTSA) is often the only remaining form of treatment in these patients. The aim of this study was to evaluate the clinical outcome after conversions from a failed HA to rTSA. **Material and Methods:** A total of 35 patients, in whom a HA, as treatment for a fracture of the proximal humerus, had failed, underwent conversion to a rTSA. A total of 28 were available for follow-up at a mean of 61 months (37 to 91), having been initially reviewed at a mean of 20 months (12 to 36) postoperatively. Having a convertible design, the humeral stem could be preserved in nine patients.

- The stem was removed in the other 19 patients and a conventional rTSA was implanted. At final follow-up, patients were assessed using the American Shoulder and Elbow Surgeons (ASES) score, the Constant Score, and plain radiographs. **Results:** At final follow-up, the mean ASES was 59 (25 to 97) and the mean adjusted Constant Score was 63% (23 to 109%). Both improved significantly ($P < 0.001$). The mean forward flexion was 104° (50 to 155°) and mean abduction was 98° (60 to 140°). Nine patients (32%) had a complication; two had an infection and instability, respectively; three had a scapular fracture; and one patient each had delayed wound healing and symptomatic loosening. If implants could be converted to a rTSA without removal of the stem, the operating time was shorter (82 min vs 102 min; $P = 0.018$). **Conclusion:** After failure of a HA in the treatment of a proximal humeral fracture, conversion to a rTSA may achieve pain relief and improved shoulder function. The complication rate is considerable.
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 34. • Kim K, Elbuluk A, Jia N, Osmani F, Levieddin J, Zuckerman J, et al. Revision shoulder arthroplasty: Patient-reported outcomes vary according to the etiology of revision. *J Orthop*. 2018;15(4): 922–6. <https://doi.org/10.1016/j.jor.2018.08.030> **Background: The study evaluates patient-reported outcomes in revision shoulder arthroplasty (RevSA) according to etiology. Methods: Twenty-three consecutive RevSA (minimum 2-year follow-up) were retrospectively reviewed. Patient-reported outcome (PRO) scores and range of motion were compared by the type of revision procedure and indication. Results: EQ5D-QOL, VAS-pain, ASES, and forward elevation improved after RevSA. The infection group had least improvements. Revision to a reverse total shoulder arthroplasty (RTSA) demonstrated the most improvement in VAS-pain, forward elevation, and ASES. Conclusions: Revision to RTSA significantly improved PRO scores compared with hemi- or total shoulder arthroplasty. RevSA for infection demonstrated the least improvement in outcomes.**
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