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Reverse hemiarthroplasty? What happens when a patient forgoes the second stage of a 2-stage glenoid bone graft reconstruction in revision shoulder arthroplasty: a report of 3 cases

Christopher M. Kilian, MD *, T. Bradley Edwards, MD

Fondren Orthopedic Group, Texas Orthopedic Hospital, Houston, TX, USA

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Revision shoulder arthroplasty is becoming more common as the number of primary shoulder replacements continues to increase. Causes of revision surgery after shoulder arthroplasty include infection, aseptic loosening, fracture, soft tissue failure, instability, and prosthetic failure.[1,3,4,6,8,14,17,18,22,28,29] Large bony glenoid defects often occur as a result. The development of the reverse shoulder arthroplasty has been a powerful tool in treatment.

The common practice at our institution is to perform revision to reverse shoulder arthroplasty in cases of glenoid bone loss. Most often this is done in a single surgical setting, but the severity of the glenoid bone loss occasionally requires consideration of a 2-stage approach. The first stage entails use of autogenous iliac crest bone graft (ICBG) on the backside of the glenoid baseplate, around a long central post. The baseplate is fixed into place using the peripheral screws. Insertion of the glenosphere follows, but the humeral component is not implanted. This allows for graft incorporation before the semiconstrained humeral device is placed 3 to 6 months later. For some patients, the symptomatic relief occurring after the first stage was enough for them to forego the planned second stage. We present 3 patients who underwent this uncommon treatment option of reverse hemiarthroplasty.

Case report

Patient 1

A 48-year-old right hand–dominant man presented with end-stage osteoarthritis of his left shoulder. He underwent uncomplicated, noncemented, left total shoulder arthroplasty after nonoperative management failed (Fig. 1, *A*). His preoperative Constant and American Shoulder and Elbow Surgeons (ASES) scores were 40 and 16, respectively.

A pegged glenoid component was used. The patient initially did well. By approximately 8 years postoperatively, the patient began developing pain and decreased mobility and strength resulting from glenoid loosening with bone loss (Fig. 1, *B*). Shortly thereafter, he underwent single-stage reverse shoulder arthroplasty with autogenous ICBG (Fig. 1, *C* and *D*). Unfortunately, the glenoid component failed within 2 months, presumably from lack of adequate fixation (Fig. 1, *E* and *F*).

An additional revision was performed, scheduled in 2 stages. The first stage included removal of the humeral and glenoid components, with use of the same bone graft to reconstruct the glenoid, placement of all glenoid components including the glenosphere, and leaving the humeral component out. This allowed glenoid bone graft incorporation before reinsertion of the humeral components. At 6 months postoperatively, radiographs showed bone graft incorporation, and the patient reported significantly decreased pain, increased shoulder mobility and strength, and improved function.

Despite our recommendation, the patient did not desire to undergo the second stage for reimplantation of the humeral component (Fig. 1, *G-I*). At 1-year postoperatively, his Constant and ASES

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* Corresponding author: Christopher M. Kilian, MD, Fondren Orthopedic Group, Texas Orthopedic Hospital, 7401 S Main St., Houston, TX 77030, USA.
E-mail address: cmk12985@gmail.com (C.M. Kilian).

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Figure 1 Patient 1: (**A**) first follow-up after total shoulder arthroplasty (TSA), anterior-posterior (AP) view; (**B**) TSA glenoid failure, AP view; (**C**) first follow-up after reverse shoulder arthroplasty (RSA), AP view; (**D**) first follow-up after RSA, axillary view; (**E**) failure of glenoid, AP view; (**F**) failure of glenoid, axillary view; (**G**) last follow-up, AP view; (**H**) last follow-up, axillary view; (**I**) last follow-up, scapular Y view.

scores were 18 and 24, respectively. He was allowed to use the shoulder as tolerated. At 3.5 years from his last surgical procedure, his active shoulder mobility was 80° forward flexion, 80° abduction, 35° external rotation, and internal rotation to the buttock. Constant and ASES scores were not available. His radiographs showed a large inferior glenoid osteophyte, stable position of the glenosphere with bone graft incorporation at the glenoid, and acetabularization of the humerus. The patient was very satisfied with his function and continues to forego stage 2 of this operation.

Patient 2

A 42-year-old right hand–dominant man, who had previously undergone multiple arthroscopic operations for instability, presented with end-stage instability arthropathy of his right shoulder. He underwent uncomplicated, noncemented, right total shoulder arthroplasty after nonoperative management failed (Fig. 2, *A*). His preoperative Constant and ASES scores were 34 and 14, respectively. A keeled glenoid component was used. The patient did well initially with improved function and mobility. However, by 5 years postoperatively, aseptic loosening developed of the glenoid (Fig. 2, *B*).

The patient was scheduled for single-stage reverse shoulder arthroplasty using autogenous ICBG. Given tenuous fixation and severe bone loss visualized during the procedure, a decision was made intraoperatively to stage this procedure. The procedure consisted of removal of the humeral and glenoid components, ICBG placement on the baseplate, and screw fixation of the ICBG/baseplate construct, followed by glenosphere placement. At 6 months postoperatively, radiographs showed bone graft incorporation. The patient reported significantly decreased pain and increased shoulder motion and strength, with improved function.

Despite our recommendation, the patient did not desire to undergo the second stage for reimplantation of the humeral components. He was allowed to use the shoulder as tolerated. A nondisplaced greater tuberosity stress fracture occurred 2.5 years postoperatively, accompanied by pain and decreased mobility (Fig. 2, *C*). After 1 month of selective rest, activity modification, and sling use, his pain resolved and his motion returned. At 5 years from his last surgical procedure, his active shoulder mobility was 155° forward

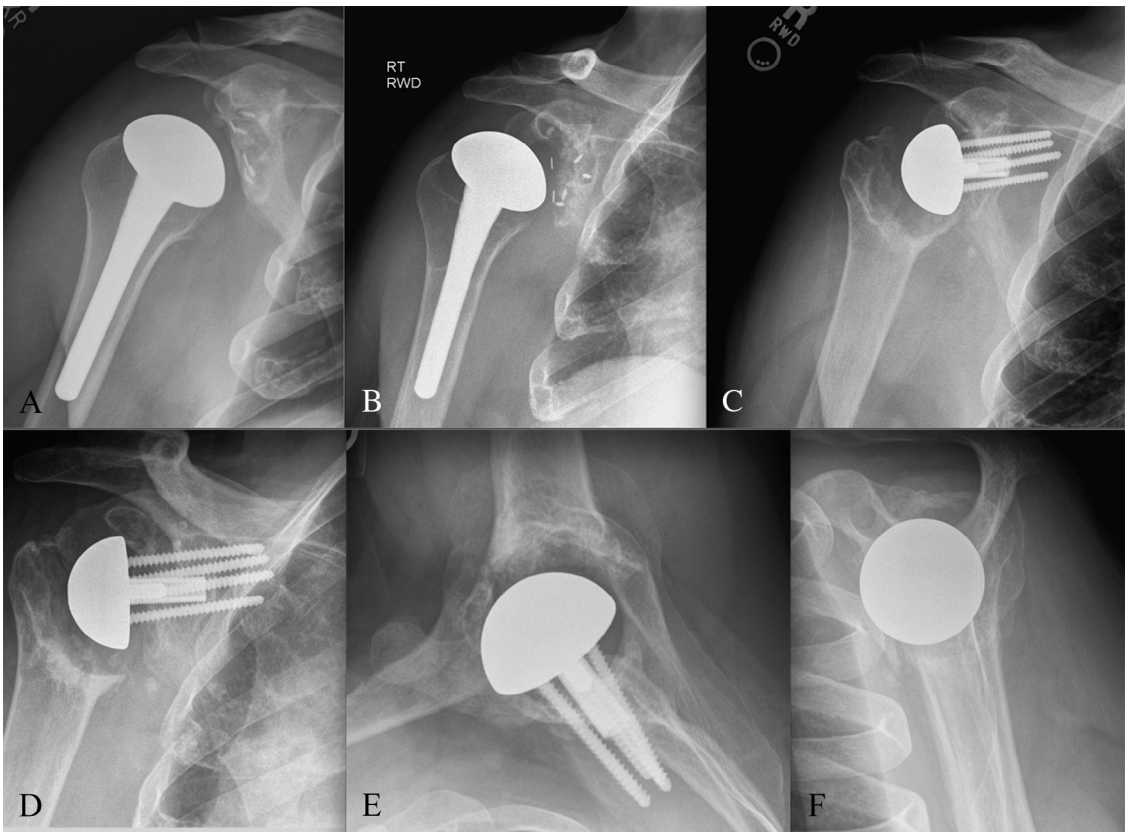

Figure 2 Patient 2: (**A**) first follow-up after total shoulder arthroplasty (TSA), anterior-posterior (AP) view; (**B**) TSA glenoid failure, AP view; (**C**) greater tuberosity fracture at 2.5 years postoperatively, AP view; (**D**) last follow-up, AP view; (**E**) last follow-up, axillary view; (**F**) last follow-up, scapular Y view.

flexion, 155° abduction, 35° external rotation, and internal rotation to L3. His Constant and ASES scores were 59 and 15, respectively. His radiographs showed stable position of the glenosphere with bonegraft incorporation at the glenoid and acetabularization of the humerus, without any visible fracture (Fig. 2, *D-F*). The patient was very satisfied with his function and continues to forego any additional procedure.

Patient 3

A 37-year-old right hand–dominant woman presented with severe juvenile rheumatoid arthritis. She had previously undergone multiple total joint arthroplasties, including hip, knee, elbow, and bilateral shoulder hemiarthroplasties with other surgeons (Fig. 3, *A*). Both shoulder arthroplasties failed due to massive rotator cuff tears and severe glenoid erosion (Fig. 3, *B*). At this point, Constant and ASES scores were 20 and 26, respectively.

She elected to undergo right revision to reverse shoulder arthroplasty, using autogenous ICBG. Given the tenuous fixation and severe bone loss visualized during the procedure, the decision was made intraoperatively to stage this procedure. This consisted of removal of the humeral component, ICBG placement on the baseplate, screw fixation of the ICBG/baseplate construct, and glenosphere placement.

Radiographs at 6 months postoperatively showed stable glenoid components, with some bone graft incorporation. There was also acetabularization of the humerus (Fig. 3, *C-E*). She reported significantly decreased pain, increased shoulder mobility and strength, and improved function. Her active shoulder mobility was 100° forward flexion, 100° abduction, 0° external rotation, and internal rotation to the lumbosacral junction. Her Constant and ASES scores were 38 and 51, respectively. During the postoperative period, an infection developed around a previously placed total hip arthroplasty.

At 7 months after the shoulder surgery, the patient developed increasing pain and swelling at her shoulder surgical site. Purulent fluid was aspirated. She underwent explantation of her shoulder component with antibiotic bead placement but did not undergo replantation of a shoulder component. The patient subsequently died approximately 3 years after her last shoulder operation of sepsis from a separate arthroplasty-related infection.

Discussion

As the number of primary shoulder arthroplasties has increased, an increased incidence of revision surgery has naturally followed.[1,4,6,17,28] Consequently, orthopedists performing shoulder arthroplasty must be familiar with revision options for these complex problems. Reverse shoulder arthroplasty has emerged as a powerful option in salvage situations.[2,3,6,7,14,15,18,24,29] Glenoid bone loss is commonly encountered in revision shoulder arthroplasty and must be addressed to maximize baseplate fixation and prevent component loosening.

Structural bone grafting of a large glenoid bone defect, both in the primary and revision setting, has emerged as an attractive option to address this issue.[10,14,20,21,24,27] Acquired bone defects are present in nearly 40% of patients with cuff tear arthropathy undergoing reverse shoulder arthroplasty.[16,24] Therefore, use of a bone graft behind the baseplate has become an established technique. Boileau et al[5] used a humeral head autograft to increase glenoid component lateralization and address acquired glenoid bone loss. The humeral head autograft incorporated completely in 98% of cases by 28 months. There was no graft resorption, glenoid loosening, or

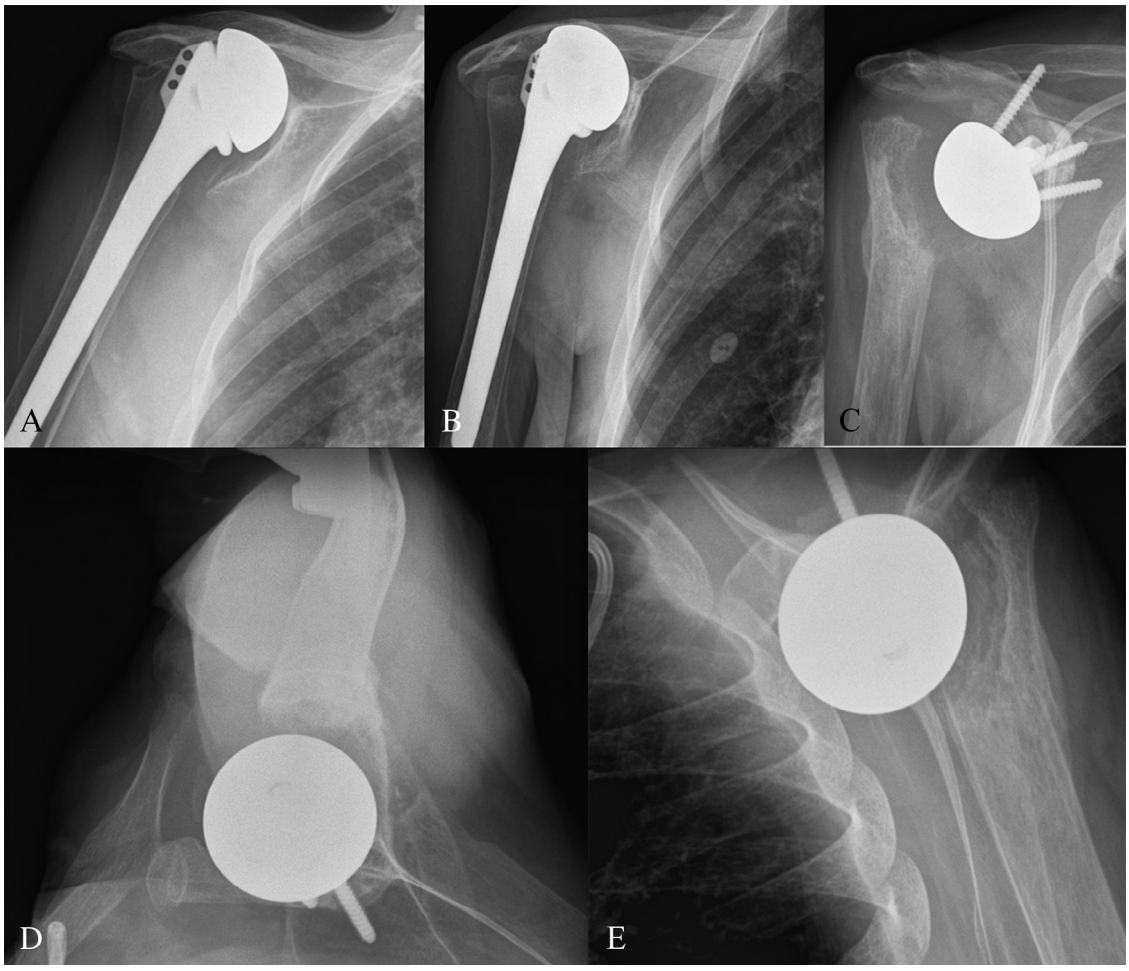

Figure 3 Patient 3: (**A**) first appointment with hemiarthroplasty, anterior-posterior (AP) view; (**B**) hemiarthroplasty failure, AP view; (**C**) last follow-up, AP view' (**D**) last follow-up, axillary view; (**E**) last follow-up, scapular Y view.

postoperative instability.[5] In a study by Wagner et al, [27] patients had significant pain relief and improvement in shoulder range of motion after undergoing glenoid bone grafting in the primary setting. Survival rates free of radiographic glenoid loosening were 92% at 2 years and 89% at 5 years.[27]

In 2007, Norris et al[22] reported a new technique at the time to address these glenoid bone defects using a tricortical ICBG secured on the back of a glenoid baseplate. This has emerged as the technique of choice for many in the revision scenario when the humeral head is not available as a graft source. Neyton et al[20] reported a minimum 2-year follow-up of 9 patients who underwent revision to a reverse with glenoid bone grafting, using multiple techniques. Despite low postoperative functional scores, most patients were satisfied with their result because of pain relief. No component loosening, graft failure, or revision surgery occurred.[20] Kelly et al[15] reported outcomes of revision shoulder arthroplasty performed for rotator cuff–related instability or bone defects. These patients showed an increase in forward flexion, ASES pain score, and an 80% satisfaction rate. However the series identified a complication rate of 50% and a revision rate of 23%.[15]

High reoperation rates occur after glenoid bone grafting in the revision setting, in both anatomic and reverse shoulder arthroplasty.[3,7,12,13,27] With revision anatomic shoulder arthroplasty, Hill and Norris[12] reported unsatisfactory results from glenoid component loosening at long-term follow-up after bone grafting of glenoid defects with implantation of a glenoid component in the same surgical setting. Cofield and Edgerton[7] suggested that in cases of extreme bone loss, one may perform bone grafting without placing a new glenoid component at the same surgical setting.

Unfortunately, there is a paucity of literature available discussing glenoid bone grafting in revision to a reverse shoulder arthroplasty.[3,20,21,27] Even less common is the discussion of performing a 2-stage revision for these instances. Norris et al[22] suggested performing a 2-stage revision if the glenoid baseplate does not have sufficient stability intraoperatively. Neyton et al,[20,21] in 2004 and 2007, reported outcomes of patients who underwent 2-stage procedures. They suggested a 2-stage procedure be performed when perceived weakness of glenoid fixation exists during the operation.[20,21]

The semiconstrained nature of reverse shoulder arthroplasty places increased stresses on glenoid fixation. If fixation of a structural bone graft is not possible intraoperatively, orthopedists are only left with the option of resection arthroplasty or hemiarthroplasty as a salvage. Unfortunately, these results are often suboptimal.[9,11,19,23,25,26] Rispoli et al[23] examined 18 patients who underwent resection arthroplasty for various reasons. The mean active elevation was 70°, improving from 39°, with minimal change in internal/external rotation. The mean ASES score was 36, and the simple shoulder test was low, at 3.1. The patients generally obtained pain relief but had poor shoulder function.[23]

Muh et al[19] reviewed 26 patients with resection arthroplasty at mean follow-up of 41.8 months. These patients improved on the visual analog scale pain but had a poor functional outcome.[19] Glanzmann et al[11] offered hemiarthroplasty as an alternative to resection arthroplasty in cases of failed reverse shoulder arthroplasty

with poor glenoid bone stock. Unfortunately, this resulted in poor functional outcome scores and inconsistent pain relief in the 16 patients observed.[11]

In this case report, we offer an alternative revision solution to resection arthroplasty, standard hemiarthroplasty, or 1-stage bone grafting with poor fixation of the glenoid. We suggest the technique of reverse hemiarthroplasty be added to the shoulder surgeon's armamentarium. To our knowledge, no published reports have specifically discussed this as an option. Our team did not realize this treatment solution intentionally, but with the outcomes observed, it has become an option for these difficult patients. Given the low functional outcomes observed with resection arthroplasty and conventional hemiarthroplasty, a reverse hemiarthroplasty after glenoid bone grafting may offer a viable solution in those who are unable or unwilling to undergo a 2-stage procedure.

The operation in the 3 patients in this report resulted in significant pain relief, with subjectively improved functional outcome compared with before the revision. Patients 1 and 2 both chose to forego stage 2 of the operation, given these profound improvements. Patient 3 was also satisfied with her pain and functional result after stage 1, but given her multiple medical comorbidities and joint infections, resection arthroplasty was her only option before she died.

It appears that for these patients to function with altered shoulder kinematics, bony changes do occur at the proximal humerus. Similar to acetabularization of the acromion in cuff tear arthropathy patients, it appears the humerus "acetabulzarizes," to allow progressive motion of the humerus on the glenosphere. In our 3 patients, this bony adaptation allowed surprisingly functional mobility with minimal, if any, pain. The lack of a constrained device on the humerus, while continuing motion of the arm, appears to allow adequate bony healing of the glenoid bone graft. No instances of glenoid loosening occurred in these 3 patients.

Of course, there are some potential concerns with this technique. As in patient 2, greater tuberosity fracture is possible given the significant stress placed through this relatively thin area of bone. However, despite this nondisplaced fracture in patient 2, healing did occur, with return of mobility without pain. Subsequently, with bony changes in the proximal humerus, it is reasonable to worry about complete erosion of this area, resulting in worsening pain and function. An outcome similar to a resection arthroplasty would likely result if this occurred. In addition, although we did not observe loosening of the glenoid component, this may occur with motion of the arm, especially because the decision to perform a procedure with 2 stages is mostly made due to tenuous glenoid fixation. Perhaps a better option may be to restrict motion until bony incorporation of the glenoid has occurred. However, as described in these 3 patients, performing a reverse hemiarthroplasty may be a viable option in special circumstances, with surprising improvements not only in pain but also in function.

Conclusion

We present a new option for patients otherwise requiring 2-stage glenoid bone grafting in revision shoulder surgery: reverse hemiarthroplasty. This seldom described, often-staged procedure has not been previously defined as a treatment option in this patient population. These patients undergo adaptive remodeling at the area of the greater tuberosity, with significant improvements in pain and range of motion, resulting in a viable option for those who forgo the second stage of this revision shoulder arthroplasty.

Disclaimer

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