

Reverse Shoulder Arthroplasty as Treatment for Comminuted Proximal Humeral Fractures in Elderly Patients

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Abstract

The results of hemiarthroplasty as treatment for comminuted humerus fractures are poor in elderly patients. While hemiarthroplasty is also an unreliable treatment for rotator cuff tear arthropathy, reverse shoulder arthroplasty (RSA) has been a reliable salvage procedure. The present study examines the result of RSA as treatment for comminuted proximal humeral fractures in elderly patients.

Thirteen elderly patients underwent RSA for comminuted proximal humeral fractures. Follow-up ranged from 8 months to 46 months. Patients were assessed retrospectively for Constant-Murley score, rate of complications, and postoperative radiographic review, and data were compared to historical controls.

Mean Constant-Murley score was 67 points (range, 45-77 points). No dislocations occurred. Two patients sustained a postinjury auxiliary nerve palsy, one of which resolved only partially. One patient sustained a postinjury radial nerve palsy that resolved. One patient underwent evacuation of a postoperative wound hematoma. No shoulder needed revision.

RSA should be considered a salvage procedure, whether performed for cuff tear arthropathy or severe proximal humerus fracture. Even so, RSA can provide immediate shoulder stability for elderly patients with severe shoulder injuries, and results compare favorably to historical controls for hemiarthroplasty in these patients.

Proximal humerus fractures—the third most common fracture after wrist and hip fractures—account for 5% of all fractures and are likely to become more prevalent because of its association with poor bone density and increasing age.¹ Complex

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3- and 4-part highly displaced fractures are severe injuries that occur in association with the most severely osteopenic bone and are challenging to treat surgically. Humeral head fragmentation often occurs and the fragments may be displaced widely. Plate internal fixation often is not possible because of comminution and poor bone porosity. In this scenario, avascular necrosis is common and may become more likely with the exposure of plate internal fixation. Under these circumstances, humeral head replacement is often necessary.

Although it reliably controls pain in cases involving severe fractures, hemiarthroplasty is unreliable in restoring shoulder function. The consensus is that function in this setting hinges on successful fixation and on subsequent union of the tuberosity fragments during surgery,²⁻⁵ and that these outcomes often are difficult to obtain because of poor tissue and bone quality. Poor shoulder function after hemiarthroplasty is often associated with nonunion, displacement, and resorption of tuberosity fragments.

Several authors have described positive results using the reverse total shoulder prosthesis for treatment of complex fractures in elderly patients.^{6,7} The reverse prosthesis has been suggested as a treatment option in cases in which the tuberosity fragments cannot be secured, or the rotator cuff cannot be salvaged during hemiarthroplasty. We conducted a study to evaluate reverse shoulder replacement in a selected series of elderly patients who sustained severe 3- or 4-part proximal humerus fractures.

MATERIALS AND METHODS

Between February 2006 and September 2009, 13 patients (8 women, 5 men) had reverse total shoulder replacement performed for a severe 3- or 4-part fracture of the proximal humerus. In all cases, the Reverse Shoulder Prosthesis (Encore Medical, Austin, Texas) was used. Eight of the patients sustained a 4-part fracture (Neer classification⁸). The humeral head was dislocated in 6 cases. Mean age was 70 years (range, 58-90 years).

Arthroplasty was performed through the deltopectoral approach with the patient positioned in the beach-chair position. Whether to perform reverse shoulder replacement was based on fracture configuration, tuberosity size and quality, humeral shaft remnant, and patient age. The final decision as to whether

Table I. Results for Study Group vs Historical Control Group

Measurement	Study Group ^a (n=13)	Control Group ^b (n=122)
Mean age, y	70	72
Mean follow-up, y	2.4	2.4
Mean active abduction, °	114	152
Mean active forward elevation, °	125	163
Mean constant-Murley score		
Total score (out of 100)	67	84
Pain score (out of 15)	11	13
Range of motion score (out of 40)	32	37
Strength score (out of 25)	12	20
Activity score (out of 20)	12	14

^aReverse procedure. ^bContralateral procedure.

to use plate internal fixation, hemiarthroplasty, or reverse arthroplasty was made during surgery. Reverse shoulder replacement was considered a salvage procedure in all cases.

The humeral component was inserted with cement in neutral version to enhance anterior stability. The glenosphere was inserted without cement and was positioned slightly inferior to the glenoid center, and then it was angled 15° inferiorly to diminish scapular notching and to decrease shear strain at the interface between the glenoid base plate and the bony glenoid. If the rotator cuff was reasonably salvageable, particularly if the supraspinatus with the associated greater tuberosity fragment was salvageable, reverse arthroplasty was deemed unnecessary, and hemiarthroplasty was performed. Hence, the remnants of the rotator cuff were poor in this series. However, the salvageable tuberosity remnants were reduced and fixed to the humeral shaft with Ethibond No. 2 sutures after reduction of the shoulder. These remnants often consisted of portions of the subscapularis and teres minor.

Immediately after surgery, management consisted of a simple sling. Basic passive range of motion movements, such as Codman and pendulums, began 1 week after surgery. At 6 weeks, isometric strengthening without resistance and overhead pulley passive range of motion exercises were started.

Follow-up ranged from 8 months to 46 months. Patients' cases were assessed retrospectively with Constant-Murley⁹ scores, complication rates, and postoperative radiographic review.

Resulting data from the study group were compared with results other authors found and reported in the literature when treating similar fractures of equivalent severity with hemiarthroplasty. Although we had a series of proximal humerus fractures that were managed at our institution with hemiarthroplasty, we chose the historical control group because the group at our institution represented much less severe injuries and, therefore, the 2 cohorts would not have been well matched with regard to injury severity.

RESULTS

For the study group, mean Constant-Murley score was 67 points (range, 45-77 points) (Table I). Seven patients reported minimal to no pain, 3 reported mild occasional pain, and 3 reported recurrent moderate shoulder pain. Mean active forward elevation (AFE) was 125° (range, 85°-170°) (Figure 1). Only 1 patient did not obtain 90° of forward flexion.

Radiographs were reviewed at latest follow-up (Figures 2, 3). The components did not show any evidence of loosening. Scapular notching was found in 3 cases but did not reach the inferior glenoid fixation screw in any of them. Union and position of the tuberosity fragments were assessed. Only 5 shoulders had the tuberosity fragments unite in situ. The tuberosities did not unite in 4 shoulders and had resorbed in 4.

There were no postoperative dislocations. Table II lists the 4 complications in the study group that occurred: 2 postinjury auxiliary nerve palsies (one resolved partially; the other resolved completely without intervention), 1 postinjury radial nerve palsy (resolved without intervention), and 1 postoperative wound hematoma (the



Figure 1. Example of postoperative active forward elevation.



Figure 2. Preoperative radiograph of severe proximal humerus fracture.

Table II. Postoperative Complications in Study Group

Complication	Outcome
Axillary nerve palsy	Resolved
Axillary nerve palsy	Partially resolved
Radial nerve palsy	Resolved
Wound hematoma	Evacuated

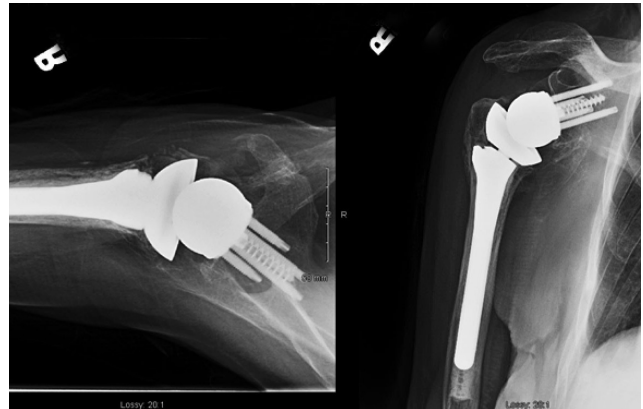
patient had been taking warfarin for cardiac reasons, before the shoulder injury, and presented with a wound hematoma 1 week after surgery to undergo evacuation; international normalized ratio was 3.9). None of the shoulders needed revision.

Table III lists the complications that occurred after hemiarthroplasty in the historical control group.

DISCUSSION

Patients with severely displaced 3- or 4-part proximal humerus fractures are at risk for developing avascular necrosis of the humeral head, particularly if managed with open reduction and internal fixation (ORIF), which is often difficult because of the degree of fragment displacement, comminution, and osteoporosis. Humeral head splitting fractures may be present. For these reasons, humeral head replacement is indicated when ORIF is not possible, or when the humeral head is not viable. Satisfactory shoulder function after hemiarthroplasty hinges on, among other factors, the surgeon's ability to adequately reduce and fix the tuberosities to the metaphysis during surgery. Tuberosity fixation must be secure horizontally as well as vertically. However, in cases with substantial metaphyseal comminution, tuberosity fixation and cuff integrity may be unsalvageable. In addition, some patients may have preexisting rotator cuff disease with or without arthropathy.

Historically, hemiarthroplasty has produced satisfactory pain control, but it is associated with only varying degrees of shoulder function when used as treatment for severe proximal humerus fracture. In a meta-analysis, Kontakis and colleagues¹⁰ compiled 810 hemiarthroplasties from 16 studies of proximal humerus fractures. Mean

**Figure 3. Postoperative radiographs of reverse total shoulder**

age was 62.7 years, mean AFE was 106.7°, and mean Constant-Murley score was 56. Antuña and colleagues⁴ reviewed a series of 57 hemiarthroplasties performed for proximal humerus fractures with a minimum follow-up of 5 years. Results were satisfactory in 27 patients and unsatisfactory in 30 patients (modified Neer scale¹¹). Most of the poor results were attributed to elevation of the humeral head and tuberosity-related problems. The authors noted that, compared with younger patients, elderly patients tended to fare less well after hemiarthroplasty, and they suggested nonoperative management should be considered for these patients.

Grammont and Baulot¹² designed the reverse total shoulder prosthesis to reconstruct the shoulder in the setting of cuff tear arthropathy. Over years of clinical use, reverse total shoulder replacement (RTSR) has been extended to managing other shoulder conditions that have similar dysfunction of the rotator cuff along, and incongruity, of the glenohumeral articulation. Elevation of the humeral head with concomitant rotator cuff dysfunction is common among elderly patients who fare poorly after hemiarthroplasty.¹³ RTSR has been used to manage failed hemiarthroplasty,¹⁴ malunion of the proximal humerus,¹⁵ and comminuted proximal humerus fracture.⁶

In a retrospective review, Sirveaux and colleagues¹⁶ reported mean AFE of 107° and mean Constant-

Table III. Postoperative Complications in Historical Control Group^a

Analysis	No. of Patients	Mean Age	No. of Complications	Complication Type
Atuna 2008	57	66	2	revision
			1	removal
Solberg 2009	48	75	1	dislocation
			4	loss of fixation
			3	infection
			7	tuberosity nonunion
Gallinet 2009	17	74	3	infection
			1	axillary nerve palsy
			2	reflex sympathetic dystrophy
			1	infection

^aAll patients underwent hemiarthroplasty.

Murley score of 55 in 15 patients after reverse total shoulder arthroplasty (RTSA) for proximal humerus fracture. The authors compared these cases with a group treated with hemiarthroplasty and found that, when the tuberosities did not heal, mean AFE was 75° and mean Constant-Murley score was 41. Cazeneuve and Cristofari⁶ reported mean AFE of 129° and mean Constant-Murley score of 60 in 23 patients who underwent RTSR for proximal humerus fracture, despite the fact that 53% of cases demonstrated failure of the tuberosities to unite.

However, Bufquin and colleagues¹⁷ reported on 43 acute fractures managed with RTSA. Mean age was 78 years, mean AFE was 97°, and mean Constant-Murley score was 44. These results, which compare less favorably, may be related to the older patient population and perhaps to the implant design¹⁸ (Delta Reversed Shoulder Prosthesis; DePuy, Saint Priest, France). Scapular notching, less common in our series than in the series reported by Bufquin and colleagues, may be related to the increased lateralization of the center of rotation incorporated in the implant design used in our study. Gallinet and colleagues⁷ compared 19 patients treated with RTSR (Delta III, DePuy) with 20 patients treated with hemiarthroplasty. The RTSR group had a mean AFE of 79° and a mean Constant-Murley score of 53, compared with 53° and 39 points in the hemiarthroplasty group.

Satisfactory hemiarthroplasty outcomes hinge on the ability to reduce, fix, and unite the tuberosities to restore rotator cuff function. In cases in which reduction and fixation of the tuberosity fragments are deemed inadequate during surgery, RTSR is an attractive salvage option.

One drawback in comparing outcomes of RTSR and hemiarthroplasty is that shoulders treated with RTSR often represent the most severely displaced and comminuted fractures. For example, the study's lead author (R.D.R.) selects RTSR as treatment for more severe injuries. Even so, satisfactory results can be achieved for this challenging condition.

A limitation of this study is that we did not use a formal control group of fractures managed with hemiarthroplasty. Additionally, the study's sample size was small.

RTSR should be considered a salvage procedure, whether performed for cuff tear arthroplasty or severe proximal humerus fracture. Nevertheless, RTSA has the advantage of providing immediate postoperative shoulder stability for elderly patients with severe proximal humeral fractures. In many cases, it may not be possible to achieve immediate postoperative stability with plate internal fixation because of poor bone quality and fragment comminution. In addition, if the rotator cuff and tuberosity fragments, in particular the supraspinatus, cannot be salvaged and securely fixed to the humeral

metaphysis, hemiarthroplasty is not likely to provide reliable postoperative function. Even in this scenario, though, hemiarthroplasty may provide satisfactory pain relief.

AUTHORS' DISCLOSURE STATEMENT

The authors report no actual or potential conflict of interest in relation to this article.

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