Analysis of Intermediate Outcomes of Glenoid Bone Grafting in Revision Shoulder Arthroplasty

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Abstract

Failed total shoulder arthroplasty (TSA) with glenoid bone defect is a difficult clinical problem. Large bone defects may preclude inserting a new glenoid component and require conversion to hemiarthroplasty with glenoid bone grafting. Although previously published data showed modest functional improvement in patients who underwent such treatment, outcomes might have been better if rotator cuffs were intact.

We retrospectively reviewed the clinical outcomes of 14 shoulders (13 patients) with failed TSA associated with moderate or severe glenoid defects, but with intact rotator cuff tendons. Outcomes at a mean (SD) of 44 (23) months after conversion to hemiarthroplasty with glenoid bone grafting were assessed with visual analog scale (VAS) pain score and American Shoulder and Elbow Surgeons (ASES) outcome score.

From before surgery to latest follow-up, mean (SD) VAS pain score decreased from 6.4 (1.2) to 1.6 (1.3), and mean (SD) ASES outcome score improved from 33 (11) to 72 (12). These changes were statistically significant ($P < .001$, Student t test). All patients demonstrated graft incorporation, and there was 1 complication (postoperative infection).

For patients with failed TSA with glenoid bone defect and intact rotator cuff tendons, good functional outcomes may be obtained with conversion to hemiarthroplasty with glenoid bone grafting.

Total shoulder arthroplasty (TSA) has long been considered effective in decreasing pain and improving function in patients with glenohumeral arthritis.[1-3] Growing awareness, coupled with an increasingly active elderly population, has led to a steady rise in the use of primary TSA.[4] This increase is expected to lead to a need for more revision surgeries. Therefore, treating surgeons must recognize and address these difficult cases efficiently.

The most common TSA complication, failure of the glenoid component, accounts for up to 60% of unsatisfactory results.[1,5-8] Aseptic loosening with a variable degree and pattern of glenoid bone loss is often reported as an indication for revision shoulder arthroplasty.[9-11] With cortical wall or severe cavitary defects, immediate reimplantation of a new glenoid component may not be possible. In these instances, conversion to hemiarthroplasty with glenoid bone grafting can be considered.

Outcomes of such treatment include good to excellent pain relief (66% to 75% of patients) and modest functional improvement.[12-16] The exact reason for only modest functional improvement is unclear, but possibilities include persistent glenohumeral instability, glenoid arthrosis, and rotator cuff insufficiency. Prior studies have included heterogeneous patient populations with regard to these factors, namely, the integrity of the rotator cuff tendons.[12-15,17] In addition to producing inferior motion, rotator cuff dysfunction may increase the likelihood of glenoid bone graft resorption.[15] Therefore, the overall outcome of revision hemiarthroplasty with glenoid bone grafting may actually be better in those patients with intact rotator cuffs.

We retrospectively reviewed our case series of patients with failed TSA and glenoid bone loss treated with conversion to hemiarthroplasty and glenoid bone grafting. All patients were documented as having an intact rotator cuff during the revision surgery. We compared their outcomes with those of patients in previous studies.

Materials and Methods

This study was approved (S12-03459) by the institutional review board at New York University School of Medicine.

We identified 17 patients (18 shoulders) who had revision shoulder arthroplasty for documented glenoid loosening between 2001 and 2008, with intact rotator cuffs. All procedures were performed by Dr. Kwon or Dr. Zuckerman at a single institution. Follow-up was incomplete for 4 of these patients (deceased), leaving 13 (14 shoulders) in our cohort (**Table**). Of these 13 patients, 6 (6 shoulders) were women, and 7 (8 shoulders)

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Table. **Details for Patients Included in Study**

Pt	Age, y	Sex	Side	Index Surgery	Preoperative Evaluation	Stem Revised	Glenoid Defect	Glenoid Treated
1	40	F	R	IA	Radiographic metal-on-metal osteolysis	Grossly loose	Severe combined	Cancellous allograft Graphton putty
2	46	M	L	CA, prior staged glenoid replant	Radiographic glenoid loosening MRI suggest full-thickness cuff tear	No	Moderate combined	Cancellous allograft Graphton putty
3	59	M	R	IA	Radiographic glenoid subsidence CT arthrography inconclusive	No	Moderate combined	Cancellous allograft
			L	IA	Radiographic glenoid loosening	No	Moderate combined	Cancellous allograft
4	83	F	R	OA, prior HA to TSA	Radiographic glenoid dislocation Concurrent subcoracoid head dislocation	No	Severe combined	Cancellous allograft
5	80	M	R	OA, prior HA to TSA	Radiographic glenoid loosening	No	Moderate combined	Cancellous allograft Graphton putty
6	70	M	R	CA	CT arthrography consistent with glenoid loosening	No	Moderate central	Cancellous allograft
7	61	M	L	CA	CT arthrography consistent with glenoid loosening Arthroscopic metal-on-metal contact	Grossly loose	Severe central	Cancellous allograft
8	61	M	R	CA	Radiographic glenoid loosening Concurrent posterior instability	No	Severe central	Cancellous allograft Graphton putty
9	71	M	L	OA	Radiographic glenoid loosening Concurrent posterior instability	Index stem 80° retroverted	Severe central	Cancellous allograft Graphton putty
10	66	F	R	OA	Radiographic glenoid loosening MRI possible cuff tear	Grossly loose	Severe central	Cancellous allograft Graphton putty
11	70	F	R	OA	Bone scan possible loosening Arthroscopically confirmed loosening	No	Severe central	Cancellous allograft Graphton putty
12	75	F	L	OA	Radiographic glenoid subsidence CT arthrography confirmed	No	Moderate central	Cancellous allograft Graphton putty
13	75	F	R	OA	CT arthrography consistent with glenoid loosening and possible cuff tear	Monoblock	Severe central	Cancellous allograft Graphton putty

Abbreviations: Pt, patient; IA, inflammatory arthropathy; CA, capsulorrhaphic arthropathy; OA, osteoarthritis; HA, hemiarthroplasty; TSA, total shoulder arthroplasty; MRI, magnetic resonance imaging; CT, computed tomography.

were men. The index TSA procedure was performed for osteoarthritis (7 shoulders), postcapsulorrhaphy arthropathy (4), and inflammatory arthritis (3). Failed glenoid components included metal-backed designs (3 shoulders), polyethylene keel design (6), polyethylene peg design (2), and unspecified polyethylene (3). Mean (SD) time from index TSA to revision surgery was 83 (53) months. Mean (SD) patient age at time of revision surgery was 67.4 (10.1) years.

The frozen sections obtained in all cases did not reveal evidence of acute inflammation. Intraoperative surveillance cultures showed no growth in 12 shoulders, growth of *Staphylococcus epidermidis* in 1 shoulder, and growth of *Propionibacterium acnes* in 1 shoulder. The patients with positive surveillance cultures were treated with parenteral antibiotics. One complained of continued significant pain, and postoperative infection was confirmed with aspiration. Cultures were positive for *P acnes*, and the patient was treated with irrigation and debridement, component exchange, and regrafting of the bone defect 48 days after the revision surgery. After a postoperative regimen of intravenous antibiotics, the infection was clinically noted to be eradicated.

During the surgery, each patient was found to have an intact rotator cuff. The subscapularis was released with tenotomy for exposure of the glenohumeral joint and was subsequently repaired with No. 2 nonabsorbable braided sutures during closure.

In all patients, inadequate bone stock precluded implanting a new glenoid prosthesis. Inspection of the glenoid after component and cement removal revealed 8 central (2 moderate, 6 severe) and 6 combined (4 moderate, 2 severe) deficiency patterns, as described by Antuna and colleagues.[12] Glenoid components were grossly loose in all patients and were removed without difficulty. One of the shoulders with severe combined glenoid bone defect was treated with a femoral head corticocancellous

graft with impaction grafting without screw fixation. Glenoid defects in the other shoulders were filled with cancellous allograft from femoral heads. Glenoids amenable to primarily allograft chip impaction were combined with demineralized bone matrix, whereas more severe defects were treated with cancellous wedge with impaction grafting (**Figures 1A, 1B**). In 5 patients, humeral components required revision for gross loosening (3), malpositioning (1), or monoblock prosthesis (1).

All patients were treated with sling immobilization for 4 to 6 weeks after surgery. On postoperative day 1, inpatient therapists evaluated these patients for passive motion exercises. The limits of these exercises were determined by motion observed during surgery, after subscapularis repair. Passive and active-assisted motion exercises were continued for 4 to 6 weeks, and then active motion and resistance training were started.

At a mean (SD) follow-up of 44 (23) months (range, 21 to 84 months), patients were evaluated by their attending surgeon. Shoulder motion, visual analog scale (VAS) pain score, and satisfaction level were recorded, and clinical outcomes were assessed with the American Shoulder and Elbow Surgeons (ASES) validated shoulder instrument.[18] In addition, radiographs were reviewed to assess graft incorporation (**Figures 2A-2D**).

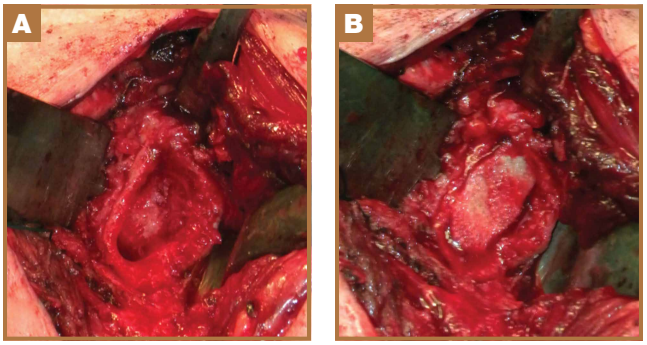

Figure 1. Intraoperative photographs of (A) severe central cavitary glenoid defect and (B) same defect treated with cancellous wedge allograft.

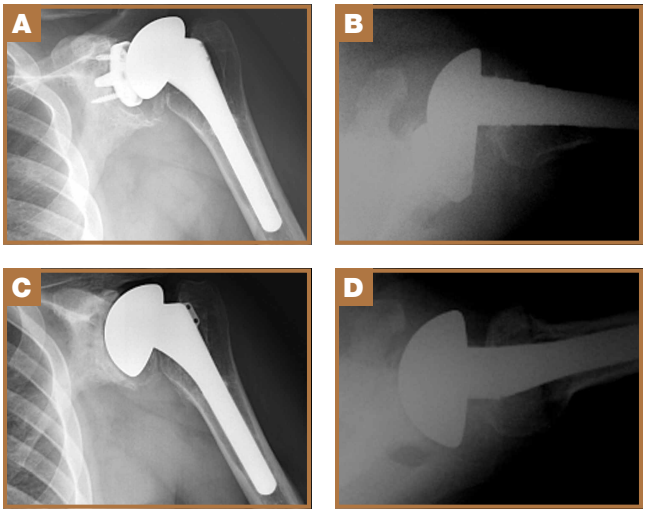

Figure 2. (A, B) Preoperative anteroposterior and axillary radiographs identifying migration of loose metal-backed glenoid. (C, D) Six months after surgery to treat severe central deficiency, radiographs show graft incorporation with mild medialization.

Results

At latest follow-up, 9 patients reported complete resolution of pain, or only mild pain with motion; the other 4 patients rated pain intermittent and associated with movement. Mean (SD) VAS pain score improved from 6.4 (1.2) before surgery to 1.6 (1.3) at latest follow-up ($P < .001$, Student *t* test). Similarly, mean (SD) active forward elevation improved from 84° (39°) to 113° (28°) ($P = .035$). There were no significant differences in active external rotation. Mean (SD) ASES outcome score improved from 33 (11) to 72 (12) ($P < .001$). For all patients, the latest radiographs showed incorporated graft, defined as progressive homogeneous mineralization of the glenoid vault at the graft site without lucency.

Thirteen of the 14 patients reported they were *satisfied* or *very satisfied* with their outcome. Further consideration for glenoid reimplantation was not planned based on subjective improvement. No significant differences were noted in outcomes of patients treated with cancellous wedge impaction grafting versus allograft cancellous chip impaction grafting combined with demineralized bone matrix.

One patient was *dissatisfied* with the outcome of glenoid bone grafting and humeral head revision. Surveillance culture was positive for *S epidermis*. After treatment with parenteral antibiotics, inflammatory markers normalized, and radiographs showed graft incorporation. Repeat aspiration has been negative for infection. Thirty months after revision surgery, however, the patient reported persistent pain with active elevation to 90° and an ASES outcome score of 50.

During revision surgery, 1 patient's surveillance culture showed growth of *P acnes*. Despite use of parenteral antibiotics, significant pain continued at rest and with gentle passive motion. Radiolucent lines were noted about the graft in the early postoperative period. Postoperative infection was confirmed with aspiration. The patient was treated with surgical debridement, component exchange, and regrafting of the glenoid 48 days after revision surgery. After treatment with intravenous antibiotics, the infection was clinically eradicated. Eighty-one months after treatment, the patient reported intermittent pain, had active elevation to 120°, recorded an ASES outcome score of 72, and was *satisfied* with his outcome.

Discussion

Glenoid component loosening after TSA continues to be a significant clinical problem.[5] Eccentric forces across the bone–cement interface are thought to be an important factor, especially when glenoid component position or cement technique is suboptimal. Contributions to these forces are likely multifactorial and include component conformity, abnormal capsuloligamentous balance, and rotator cuff deficiency.[19] After glenoid component removal and bone grafting, these factors

continue to play an important role in determining functional outcome. Consequently, studies have found increased graft resorption in patients with rotator cuff insufficiency and secondary increased eccentric forces.[15]

Based on these findings, we sought to explore whether the clinical outcomes of glenoid bone grafting and revision to hemiarthroplasty for failed TSA are better in patients with intact rotator cuffs. In this study, mean (SD) ASES outcome score after revision surgery was 72 (12); other studies have found an ASES score of 52,[13] a Penn score of 57,[17] and a Constant score of 50.[15] In addition, mean (SD) active forward elevation was 113° (28°) in our study and between 100° and 117° in other studies.[13-17] Thus, though direct comparisons are not possible, data suggest that rotator cuff status during revision surgery may influence overall function but not necessarily overall motion.

This study had its limitations, the first being lack of standardized postoperative radiographic analysis. All patients were evaluated with radiographs at final follow-up, and graft incorporation was noted in all. Despite the intact rotator cuffs, these radiographs also showed humeral head medialization, suggesting graft resorption or subsidence. However, as the immediate and final postoperative radiographs were not standardized, quantification of graft resorption/subsidence could not be reliably determined. Other studies have noted graft resorption/subsidence had an unclear effect on overall outcome.[15-17] Therefore, this analysis for our group of patients could have provided valuable information.

Another limitation was lack of a control group for direct comparison. However, with increasing use of reverse TSA, it would have been difficult to establish a comparison group of patients who had an insufficient rotator cuff but were still treated with hemiarthroplasty and glenoid bone grafting. Other limitations include the small cohort of patients, the retrospective study, and the lack of longer term follow-up.

Despite these limitations, our data agree with other studies' findings supporting use of glenoid bone grafting and conversion to hemiarthroplasty for failed TSA with glenoid bone defect. In the majority of patients with an intact rotator cuff, good overall function and significantly less pain can be obtained. Therefore, this treatment strategy may provide a reasonable alternative for patients suffering from failed TSA with glenoid defects precluding primary glenoid revision.

Conclusion

For patients with failed TSA and a glenoid containing a large residual bone defect that precludes inserting a new prosthesis, conversion to hemiarthroplasty with bone grafting of the glenoid may provide a reasonable salvage treatment option. With an intact rotator cuff, the outcome may even be better than previously reported, and good functional use with pain relief can be obtained even for these difficult clinical scenarios.

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References

1. Deshmukh AV, Koris M, Zurakowski D, Thornhill TS. Total shoulder arthroplasty: long-term survivorship, functional outcome, and quality of life. *J Shoulder Elbow Surg*. 2005;14(5):471-479.
2. Lo IK, Litchfield RB, Griffin S, Faber K, Patterson SD, Kirkley A. Quality-of-life outcome following hemiarthroplasty or total shoulder arthroplasty in patients with osteoarthritis. A prospective, randomized trial. *J Bone Joint Surg Am*. 2005;87(10):2178-2185.
3. Norris TR, Iannotti JP. Functional outcome after shoulder arthroplasty for primary osteoarthritis: a multicenter study. *J Shoulder Elbow Surg*. 2002;11(2):130-135.
4. Day JS, Lau E, Ong KL, Williams GR, Ramsey ML, Kurtz SM. Prevalence and projections of total shoulder and elbow arthroplasty in the United States to 2015. *J Shoulder Elbow Surg*. 2010;19(8):1115-1120.
5. Hasan SS, Leith JM, Campbell B, Kapil R, Smith KL, Matsen FA 3rd. Characteristics of unsatisfactory shoulder arthroplasties. *J Shoulder Elbow Surg*. 2002;11(5):431-441.
6. Brenner BC, Ferlic DC, Clayton ML, Dennis DA. Survivorship of unconstrained total shoulder arthroplasty. *J Bone Joint Surg Am*. 1989;71(9):1289-1296.
7. Hawkins RJ, Bell RH, Jallay B. Total shoulder arthroplasty. *Clin Orthop*. 1989;(242):188-194.
8. Torchia ME, Cofield RH, Settergren CR. Total shoulder arthroplasty with the Neer prosthesis: long-term results. *J Shoulder Elbow Surg*. 1997;6(6):495-505.
9. Martin SD, Zurakowski D, Thornhill TS. Uncemented glenoid component in total shoulder arthroplasty. Survivorship and outcomes. *J Bone Joint Surg Am*. 2005;87(6):1284-1292.
10. Sperling JW, Cofield RH, Rowland CM. Neer hemiarthroplasty and Neer total shoulder arthroplasty in patients fifty years old or less. Long-term results. *J Bone Joint Surg Am*. 1998;80(4):464-473.
11. Wirth MA, Rockwood CA Jr. Complications of total shoulder-replacement arthroplasty. *J Bone Joint Surg Am*. 1996;78(4):603-616.
12. Antuna SA, Sperling JW, Cofield RH, Rowland CM. Glenoid revision surgery after total shoulder arthroplasty. *J Shoulder Elbow Surg*. 2001;10(3):217-224.
13. Deutsch A, Abboud JA, Kelly J, et al. Clinical results of revision shoulder arthroplasty for glenoid component loosening. *J Shoulder Elbow Surg*. 2007;16(6):706-716.
14. Elhassan B, Ozbaydar M, Higgins LD, Warner JJ. Glenoid reconstruction in revision shoulder arthroplasty. *Clin Orthop*. 2008;466(3):599-607.
15. Neyton L, Walch G, Nové-Josserand L, Edwards TB. Glenoid corticocancellous bone grafting after glenoid component removal in the treatment of glenoid loosening. *J Shoulder Elbow Surg*. 2006;15(2):173-179.
16. Phipatanakul WP, Norris TR. Treatment of glenoid loosening and bone loss due to osteolysis with glenoid bone grafting. *J Shoulder Elbow Surg*. 2006;15(1):84-87.
17. Scalise JJ, Iannotti JP. Bone grafting severe glenoid defects in revision shoulder arthroplasty. *Clin Orthop*. 2008;466(1):139-145.
18. Richards RR, An KN, Bigliani LU, et al. A standardized method for the assessment of shoulder function. *J Shoulder Elbow Surg*. 1994;3(6):347-352.
19. Matsen FA 3rd, Clinton J, Lynch J, Bertelsen A, Richardson ML. Glenoid component failure in total shoulder arthroplasty. *J Bone Joint Surg Am*. 2008;90(4):885-896.