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ORIGINAL ARTICLE

Glenoid bone grafting in primary reverse total shoulder arthroplasty

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Background: Severe glenoid bone loss remains a challenge in patients requiring shoulder arthroplasty and may necessitate glenoid bone grafting. The purpose of this study was to determine results, complications, and rates of failure of glenoid bone grafting in primary reverse shoulder arthroplasty.

Methods: Forty-one shoulders that underwent primary reverse arthroplasty between 2006 and 2013 with a minimum follow-up of 2 years (mean, 2.8 years; range, 2-6 years) were reviewed. Thirty-four (83%) received corticocancellous grafts and 7 (17%) structural grafts.

Results: Active range of motion and pain levels were significantly improved ($P < .001$), with mean American Shoulder and Elbow Surgeons score of 77, Simple Shoulder Test score of 9, and patient satisfaction of 93% at the most recent follow-up. Preoperative severe glenoid erosion and increasing body mass index were significantly associated with worse American Shoulder and Elbow Surgeons scores ($P = .04$).

On radiographic evaluation, 7 patients (18%) had grade 1 or grade 2 glenoid lucency. Glenoid bone graft incorporation was observed in 31 patients (78%). Twelve patients (30%) suffered from grade 1 or grade 2 scapular notching. All of the patients with structural grafts showed graft incorporation and no signs of glenoid lucency.

Conclusion: Although glenoid lucency, glenoid graft resorption, and scapular notching were present at short-term to midterm follow-up, none of the patients needed revision surgery. Primary reverse shoulder arthroplasty with glenoid reconstruction using bone graft relieved pain and restored shoulder function and stability.

Level of evidence: Level IV; Case Series; Treatment Study

Keywords: Shoulder; reverse; arthroplasty; glenoid; bone; graft

Reverse shoulder arthroplasty (RSA) has become an accepted treatment option for patients suffering from glenohumeral arthritis combined with significant glenoid bone loss.[8] However, in primary or revision shoulder arthroplasty, glenoid bone loss is associated with inferior results,[3,4,11] and significant glenoid bone loss may even be considered a contraindication to implantation of a glenoid component.[4]

Hill and Norris[10] stated that unconstrained total shoulder arthroplasty combined with glenoid bone grafting has a 10-fold

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Investigation performed at the Mayo Clinic, Rochester, MN, USA.

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higher failure rate than in procedures where glenoid bone quality is adequate. Because of the inherent stability of RSA while moving the center of rotation medially and distally to increase deltoid function but also its destabilizing force,[2,3] stress at the bone-implant interface might be increased, with increased failure rates of glenoid bone grafting with a reverse design prosthesis. However, results of previous studies with smaller cohorts of 9 and 22 patients, respectively, who underwent glenoid bone grafting in primary RSA are promising.[13,19]

The purpose of this study was to evaluate the short-term to midterm outcome associated with glenoid bone grafting in primary RSA. We aimed to analyze the overall success and to elicit any predicting factors for worse outcomes.

Methods

The study sample was identified using our institutional joint registry,[1] in which all patients who undergo total joint arthroplasty are documented prospectively.

Population of patients

Between May 2006 and March 2013, primary RSA was performed in 810 consecutive patients at our institution. There were 107 patients (13.2%) who received glenoid bone grafts when undergoing RSA implantation. In 27 of these shoulders, RSA was implanted for treatment of an acute fracture or neoplasia, and these were excluded from analysis. Of the remaining 80 patients (9.9%), 41 had a minimum follow-up of 2 years, with an average of 2.8 years (range, 2-6 years). Thirty-nine of those excluded did not have 2 years of follow-up. Baseline characteristics are summarized in Table I. Cuff tear arthropathy was the primary diagnosis in 33 (80%) patients, whereas 10 (30%) patients had a history of failed rotator cuff repair. Five (12%) patients suffered from degenerative joint disease, 1 (2%) patient from rheumatoid arthropathy, 1 (2%) from chronic dislocation, and 1 (2%) from neuropathic arthropathy. Among these 8 shoulders, all had an intact rotator cuff. In addition to those with a previous rotator cuff repair, prior surgeries included open reduction and internal fixation of a proximal humeral fracture (1), arthroscopic débridement and synovectomy for septic arthritis (1), and open distal clavicle excision and secondary open acromioplasty (1).

The surgeons followed the treatment algorithm, as previously described.[24] We attempt to achieve between 30% and 50% contact between the implant and host bone. In specific instances of superior bone loss, the graft is used to promote inferior tilt of the implant. In the setting of posterior or anterior defects, the graft is used to restore glenoid version. Cancellous graft is used in the setting of lesser defects. In larger glenoid deficiencies, the use of structural grafts is considered. The final decision for glenoid bone grafting was made intraoperatively.

Table I Characteristics of the patients

Variable	Finding
N	41
Age, years	73.5 ± 8.4
BMI, kg/m^2	27.4 ± 5.7
Female	28 (68)
RSA implantation on dominant side	28 (68)
Smokers	3 (7)
Diabetes mellitus type 2	7 (17)
Laborer	5 (12)

BMI, body mass index; *RSA*, reverse shoulder arthroplasty.
Categorical variables are presented as number (%). Continuous variables are presented as mean ± standard deviation.

Operative details and surgical findings

To obtain secure fixation of the implant and bone graft, at least 2 of the glenoid baseplate screws were placed to capture the medial cortex of the scapular neck. Operative details including glenoid bone graft source and location and size of the defects are detailed in Table II. None of the patients required bone grafting of the humerus.

Implanted components were from 3 different companies, including 32 (78%) Comprehensive Reverse Shoulder Prosthesis (Biomet, Warsaw, IN, USA), 6 (15%) Delta Xtend (DePuy Orthopedics, Warsaw, IN, USA), and 3 (7%) Encore Reverse Shoulder (DJO Surgical, Austin, TX, USA). A lateral offset glenosphere was implanted in 6 (15%) shoulders, including the Comprehensive (+3 mm offset) and the Encore (+4 mm offset) design. The remaining 35 (85%) implants had a medial center of rotation (Comprehensive and Delta Xtend; no offset).

Clinical and radiographic assessment

Complications after RSA were analyzed. All 41 patients were evaluated preoperatively and postoperatively for pain and active shoulder range of motion by the treating surgeon. Internal rotation was measured by the highest spinal segment that could be reached with the thumb. Pain levels were graded on a 5-point scale: 1, no pain; 2,

Table II Operative details

Variable	Finding
Mean humeral retroversion (degrees)	29
Cemented humeral components	7 (17)
Graft source*	
Autograft (humeral head or 1 iliac crest)	39 (95)
Allograft (CanPac or femoral head)	2 (5)
Type of graft	
Corticocancellous	34 (83)
Structural (allograft or autograft)	7 (17)
Main defect location	
Superior	24 (59)
Posterior	12 (29)
Anterior	3 (7)
Inferior	2 (5)
Intraoperative fracture	
Humeral side	2 (5)
Glenoid bone	1 (2)

Data are presented as number (%) unless otherwise indicated.
* CanPac is manufactured by AlloSource (Centennial, CO, USA).