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Reverse total shoulder arthroplasty with structural bone grafting of large glenoid defects

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Background: Large glenoid defects pose difficulties in shoulder arthroplasty. Structural grafts consisting of a humeral head autograft, iliac crest, and allograft have been described. Few series describe grafts used with reverse total shoulder arthroplasty (RTSA).
Methods: We retrospectively reviewed patients who had undergone primary or revision RTSA. We identified 44 patients (20 men and 24 women; mean age, 69 years) as having a bulk structural graft to the glenoid behind the baseplate. The grafts consisted of a humeral head autograft in 29, iliac crest autograft in 1, or femoral head allograft in 14. Range of motion data, American Shoulder and Elbow Surgeons score, simple shoulder test, shoulder pain and disability index, and Constant scores were obtained from preoperative and the latest follow-up visits. Radiographs were reviewed from the initial postoperative visit and the latest follow-up. The grafting cohort was compared with an age- and sex-matched cohort of RTSA patients without glenoid grafting.
Results: Improvements were seen in the functional outcome scores at the latest follow-up. No significant differences were found in the preoperative or postoperative data between allografts and autografts. Postoperative scores for the bone graft cohort were significantly lower than those in the cohort without grafting. Complete or partial incorporation was shown radiographically in 81% of grafts. Six baseplates were considered loose. Complications included 2 infections, 1 dislocation, 1 humeral loosening, and 2 instances of clinical aseptic baseplate loosening. Six patients showed mild scapular notching.
Conclusions: The use of bulk structural grafts is a promising treatment option. Allografts may yield equally acceptable results compared with autografts.
Level of evidence: Level IV; Case Series; Treatment Study

Keywords: Bulk structural grafts; glenoid defects; reverse total shoulder arthroplasty; glenoid grafting; autograft; allograft

Lack of sufficient glenoid bone stock caused by erosion or dysplasia is one of the most difficult problems in shoulder arthroplasty. Numerous studies have reported compromised results when anatomic total shoulder arthroplasty (TSA) is performed in the presence of significant posterior glenoid erosion.[13,16,23] Iannotti and Norris[16] found that, compared with

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other patients in their study, patients with posterior subluxation of the humeral head and posterior glenoid erosion had lower final American Shoulder and Elbow Surgeons (ASES) scores, increased pain, and decreased active external rotation after TSA or hemiarthroplasty. Levine et al[20] divided glenoid wear into 2 types. Type I showed only concentric wear, and type II was nonconcentric wear. They showed only 63% satisfactory results after hemiarthroplasty in patients with type II glenoids.

Walch et al[34] developed the most commonly used classification system for glenoid morphology. Walch types B2 and C (hypoplastic) pose the most difficult reconstruction challenges. Frankle et al[10] described common glenoid wear patterns in rotator cuff tear arthropathy. These include posterior, superior, anterior, and global wear.

Adverse consequences can occur from implantation of a reverse TSA (RTSA) in patients with severely eroded glenoids. Excessive medialization of the implants can lead to inferomedial impingement causing scapular notching that results in bone erosion, instability, and polyethylene wear.[4,11] Anterior posterior impingement from significant abnormal version can limit internal and external rotation.[4,11] Finally, excessive humeral medialization can decrease deltoid wrapping around the greater tuberosity, leading to instability and cosmetic issues in some patients.[4,5,12]

Options to address abnormal wear include eccentric reaming, augmented implants, and bone grafting. Numerous studies have reported successful results of autografts with RTSA.[3,19,21,22,25,28,29] Large structural grafts from the humeral head or iliac crest have been used to reconstruct posterior, superior, and anterior defects. Screws used for baseplate fixation can be used to secure the graft. More recently, extended pegged baseplates have been used to assist fixation to the native scapula.[21,35] However, far fewer studies report results of structural allografts for glenoid reconstructions with RTSA[2,17,21,35] and, to our knowledge, no studies have compared results of allografts vs. autografts.

Our study quantified the clinical outcomes and compared results using a structural allograft or autograft placed behind the glenoid baseplate to address large structural defects of the glenoid during RTSA. We hypothesized (1) that a single-stage reconstruction for these defects combined with RTSA would achieve significant improvements in standard outcome measures and motion, (2) that there would be no difference in autograft vs. allograft outcomes, and (3) that patients requiring glenoid bone graft would not perform as well as a cohort of patients undergoing RTSA without the need for bone graft.

Materials and methods

A multicenter data registry was used to identify patient candidates from 3 fellowship-trained shoulder surgeons. Preoperative and postoperative data were analyzed from 44 patients (20 men and 24 women), with an average age of 69.1 ± 7.4 years, who received primary RTSA or revision RTSA (Equinoxe RTSA; Exactech, Inc., Gainesville, FL, USA) requiring a structural bone graft behind the baseplate for a severe glenoid defect. Average follow-up was 40.6 ± 16 months.

Thirty patients received an autograft (29 autograft humeral heads and 1 autograft iliac crest) behind the baseplate, and 14 patients received an allograft femoral head. The choice of graft was determined by the availability and quality of the humeral head. If there was no head, such as in revisions, allograft femoral head or autograft iliac crest was chosen. The head in some primary cases was too small or worn to adequately correct the deformity, and allograft was chosen.

These patients were evaluated and scored preoperatively and at the latest follow-up using the ASES, Constant, simple shoulder test (SST), and shoulder pain and disability index (SPADI) scoring metrics. Daily pain, active abduction, forward flexion, and external rotation were also measured. Measurements were performed by a physical therapist or athletic trainer using a goniometer with consistent technique between sites. A Student 2-tailed, unpaired t test was used to identify differences in preoperative and postoperative results, for which $P < .05$ denoted a significant difference.

The data were evaluated using 3 comparisons: (1) the entire cohort was evaluated by comparing preoperative vs. postoperative results; (2) the autograft group was compared with the allograft group using preoperative scores, postoperative scores, and amount of improvement; and (3) the entire cohort was compared with an age- and sex-matched control cohort of patients receiving a RTSA without bone grafting.

All patients underwent radiographic evaluation to compare immediate postoperative vs. latest follow-up images. Radiographs consisting of anteroposterior Grashey, axillary lateral, and outlet views were assessed for graft incorporation, evidence of baseplate loosening, humeral lucent lines, and scapular notching. Graft incorporation, which can be difficult to determine, was defined for the purposes of this study as fully incorporated (≥75%), partially incorporated (25% to 75%), or not incorporated (<25%) according to the amount of graft remaining at the latest radiographs. One of the authors (T.W.W.) reviewed all radiographs.

Surgical technique

A deltopectoral approach was performed in all shoulders. The biceps was tenodesed, and the subscapularis, if present, was released. After exposure of the humeral head and removal of osteophytes, the humeral head was resected and saved as a bone graft. In revision RTSA or if the humeral head was not suitable for grafting, a femoral head allograft was used for glenoid reconstruction. (An iliac crest autograph was used in 1 shoulder.) The glenoid was initially reamed slightly to provide a smoother concentric surface for the graft. Small holes were often drilled in the glenoid surface to facilitate blood flow and potentially enhance incorporation of the graft.

The graft was shaped by hand initially to achieve an approximate fit to correct the defect. Once this was satisfactorily achieved, custom inverse reamers (Exactech, Inc.) were used to ream the backside of the graft to match the previously reamed native glenoid surface more precisely. Allograft bone matrix gel was used between the graft and native glenoid to fill any small voids. The graft was provisionally held with Kirschner wires inserted at an angle that did not impede placement of the baseplate. A Kirschner wire was then inserted through the graft into the native glenoid down the center of the glenoid vault (based on finger palpation of the anterior glenoid neck at the Matsen point).