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ORIGINAL ARTICLE

Structural glenoid grafting during primary reverse total shoulder arthroplasty using humeral head autograft

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Background: Large glenoid bone defects in the setting of glenohumeral arthritis can present a challenge to the shoulder arthroplasty surgeon. The results of large structural autografting at the time of reverse total shoulder arthroplasty (RTSA) are relatively unknown.
Methods: This retrospective case series describes the clinical and radiographic results of large structural autografting from the humeral head to the glenoid during primary RTSA.
Results: Of 17 patients who met inclusion criteria, 14 (82% follow-up) were evaluated postoperatively at a mean of 2.6 years (range, 2.0-5.4 years). Mean inclination correction was 19° ± 12° (range, 3°-35°). Complications occurred in 3 patients, including 1 transient brachial plexus palsy, 1 loose baseplate, and 1 dislocation treated with closed reduction. Radiographic images showed 100% of grafts incorporated. Active forward elevation improved from 80° ± 40° to 130° ± 49° ($P = .028$). The visual analog scale score for pain improved from 8.1 ± 1.3 to 2.5 ± 3.1 ($P = .005$). The Simple Shoulder Test improved from 1.8 ± 1.1 to 6.5 ± 4 ($P = .012$). The American Shoulder and Elbow Surgeons score improved from 22 ± 10 to 66 ± 25 ($P = .012$). All patients (100%) were satisfied, and all patients (93%) but 1 stated that they would undergo the procedure again if given the chance.
Conclusions: RTSA incorporating structural grafting of the glenoid with humeral head autograft results in significant improvements in active forward elevation, pain, and function, with a low complication rate. This technique can reliably be used to achieve correction of large (up to 35°) glenoid defects with a 93% chance of baseplate survival and a 100% chance of graft incorporation in the short-term.
Level of evidence: Level IV; Case Series; Treatment Study

Keywords: Reverse total shoulder arthroplasty; glenoid bone loss; bone grafting; shoulder arthroplasty; shoulder replacement; outcomes studies

Glenoid bone defects in the setting of glenohumeral arthritis pose a significant challenge to the shoulder arthroplasty surgeon.[20,21,23] Glenoid bone defects create multiple potential issues, including compromised glenoid component stability, component impingement with resultant instability and notching, decreased bone stock for future revisions, and inadequate soft tissue tensioning.[2,3,14,29] Multiple techniques have been

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developed to address these defects, including eccentric reaming,[20] augmented glenoid components,[10,24,29] and bone grafting.[2-5,7-13,16-19,26,28] Reports of glenoid bone grafting in the setting of hemiarthroplasty and total shoulder arthroplasty have been mixed,[5,8,19] with subsidence rates ranging from 20%[19] to nearly 50%.[8]

Glenoid bone grafting in the setting of reverse total shoulder arthroplasty (RTSA) remains incompletely understood. Glenoid bone defects are common with RTSA: glenoid bone grafting may be necessary in up to 40% of primary procedures[13] and in up to 78% of revision procedures.[16] The optimal bone graft source and technique for placement and stabilization remain controversial.[13,17,18,26,28] Glenoid bone defects vary in their extent and location, and the optimal graft choice and surgical technique likely differ depending on the specific defect.[21,25,26] Specifically, central (contained and uncontained) and peripheral defects exist,[1] with the most commonly encountered wear patterns including posterior wear in glenohumeral osteoarthritis,[27] superior wear in rotator cuff tear arthropathy,[21] anterior defects in the setting of chronic anterior dislocations,[28] and global defects in the setting of revision shoulder arthroplasty.[12,18,26]

Multiple sources exist for the bone graft, including humeral head autograft,[3,18] iliac crest autograft,[16-18] cancellous autograft,[2,16] cancellous allograft,[5] femoral neck allograft,[2,21] and femoral head allograft.[4,13] The results of glenoid bone grafting in RTSA have been encouraging.[13,17,18,26,28] However, midterm survival of RTSA may be decreased when performed in the setting of glenoid bone grafting compared with an RTSA without grafting.[26] In addition, although those studies published to date have demonstrated rates of graft incorporation of between 76%[16] and 98%,[3] graft incorporation or resorption can be difficult to judge on radiographs.[6]

In the largest series to date, Wagner et al[26] distinguished between structural glenoid bone grafts and corticocancellous bone grafts, noting that 75% of failures in their series were corticocancellous and thus that structural bone grafting may necessary in some cases to achieve sufficient baseplate stability.[25] Very few prior series have focused specifically on the outcomes of structural bone grafting in the setting of RTSA for severe glenoid erosion.[25,26,28] This study describes the short-term clinical and radiographic results of structural bone grafting for severe glenoid deficiency from the humeral head in the setting of primary RTSA. We hypothesized that RTSA with structural bone grafting with a humeral head autograft would result in significant improvements in range of motion and patient-reported outcomes with high rates of graft incorporation and low rates of revision.

Materials and methods

This retrospective study included all patients undergoing RTSA with humeral head structural autograft for severe glenoid erosion. The operative log of the senior author (R.Z.T.) was reviewed between May 2008 and January 2015. Overall, 28 patients underwent RTSA with structural bone grafting for glenoid erosion. The senior author made the decision to perform an RTSA with a structural graft based on the ability to correct baseplate inclination to at least neutral tilt on a standing true anteroposterior radiograph of the shoulder and to within 10° of retroversion on an axillary radiograph without significantly reaming beyond 5 mm to 10 mm of glenoid bone stock to gain correction. The goal of reaming was to correct to 100% baseplate seating. If these goals could not be achieved with reaming alone, then RTSA with structural bone grafting was selected.

Patients who underwent primary RTSA with concomitant structural glenoid bone grafting with autologous humeral head were included. The study excluded patients who underwent RTSA with a structural glenoid bone graft as a revision of a prior arthroplasty, with an allograft, or with an iliac crest autograft. A total of 17 of the 28 patients met the criteria and were contacted to return for a clinical and radiographic evaluation.

Operative procedure

A deltopectoral approach was used in all operations. The Trabecular Metal Reverse Total Shoulder Arthroplasty (Zimmer, Warsaw, IN, USA) and the Aequalis Reversed Shoulder Arthroplasty (Tornier, Bloomington, MN, USA) systems were both used. In all cases, the humeral head was cut using the cutting guide, and the humerus was prepared according to the manufacturer's recommendations. A thicker cut was performed than usual so grafting could be performed using the cut head. The typical thickness of the cut head was between 15 mm and 20 mm. The proximal humerus was cut between 0° and 10° of retroversion in all cases.

The glenoid was exposed and assessed. The defect was decorticated with a high-speed burr, and the glenoid was perforated with a 0.062-inch Kirschner wire multiple times. All remaining cartilage was removed from the humeral head, and a segment was cut with an oscillating saw to match the defect. The baseplate guide for the system was used to place the central pin for the glenoid was at the appropriate height and inclination. The pin was positioned to achieve neutral or inferior tilt on a standing true anteroposterior radiograph and between 0° and 10° of retroversion on an axillary radiograph.

A slot was created in the graft to slide over the central pin that had been previously placed. The bone graft was placed and provisionally secured at its periphery with multiple Kirschner wires (Fig. 1). The glenoid was prepared for the baseplate according to the manufacturer's recommendations, including reaming and the central drill. The baseplate was placed, and screws were placed through the baseplate and graft and into the native glenoid to stabilize the graft. The central baseplate post was 25 mm long in all cases, achieving at least 5 mm in native glenoid.

Once the baseplate was secured, an additional 2.7-mm cortical screw was often placed superior to the baseplate from the graft into the glenoid. The glenosphere was then impacted into place. The humeral component was cemented in all cases, and a polyethylene spacer was chosen to achieve stability with minimal to no shuck and good tension in the conjoint tendon. The subscapularis was not repaired in any case.

Clinical data collection

Data collected from the preoperative documentation for each patient were operative side, side of dominance, gender, whether the patient had an active worker's compensation claim, whether the patient had