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ORIGINAL ARTICLE

Management of glenoid bone defects with reverse shoulder arthroplasty—surgical technique and clinical outcomes

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Background: Management of significant glenoid bone loss in patients undergoing a reverse shoulder arthroplasty (RSA) poses a significant treatment challenge. The long-term outcome of single-stage RSA with glenoid bone grafting is unknown. This study assesses the indications, technique, and outcome of RSA with glenoid bone grafting.

Materials and methods: Between 2001 and 2010, there were 1074 RSAs performed at our institution; 94 patients had significant glenoid bone loss. Each glenoid defect was subclassified as centric or eccentric and graded 1-4. The patients underwent a single-stage or 2-stage RSA with glenoid bone grafting. A retrospective analysis of the preoperative and postoperative clinical and radiologic outcome was carried out. The mean follow-up was 2.4 years (0.52-10.7 years).

Results: Of these patients, 17% had a centric defect and 83% had an eccentric glenoid defect. Composite glenoid grafts were required in 12 patients, 9 of whom required a glenoid baseplate with a long central peg; 92.5% (87/94) of the patients could be managed with a single-stage procedure. Improvement in the Constant score of 61 points (17.9 to 78.9; $P < .01$) and the mean Simple Shoulder Test score of 5.8 points (1.6 to 7.5; $P < .001$) was noted. No correlation was found between the clinical outcome and indication for surgery, age, location of defect, and size of defect.

Conclusion: Severe glenoid bone loss can usually be managed by a single-stage bone graft and RSA. A 2-stage procedure is recommended when primary baseplate stability is not attainable.

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

Keywords: Reverse shoulder replacement; glenoid bone loss classification; glenoid reconstruction; revision; glenoid defects; long-peg baseplate

Glenoid bone loss is often encountered in patients undergoing reverse shoulder arthroplasty (RSA). Evaluation and management of the glenoid bone defect are critical for a successful outcome. Bone loss is encountered in patients with chronic glenohumeral dislocation, in the setting of cuff tear arthropathy with glenoid bone erosion, as a consequence of failed prior arthroplasty, or as a result of failed proximal

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humeral fracture fixation with glenoid erosion due to hardware penetration.

Glenoid defects can range from small defects, which can be managed by eccentric reaming of the glenoid, to large complex centric and eccentric defects, which may require corticocancellous grafts. Significant bone loss requiring a bone graft was found in 9% of patients undergoing RSA at our institute. However, other authors have reported an incidence up to 38%.[10]

Bone grafting of glenoid defects for total shoulder arthroplasty has demonstrated poor long-term clinical results.[7,13,18,26] A high rate of graft subsidence, graft resorption, and instability has resulted in early glenoid component loosening and early failure.

RSA is a promising alternative.[4,22,23] The geometry of the prosthesis design along with a rigidly fixed baseplate provides an axial compressive force to the bone graft, which promotes graft incorporation. However, reconstruction of the glenoid anatomy and restoration of the native joint line, which are prerequisites for a successful RSA, can be difficult to attain in the setting of glenoid bone loss. Management of large glenoid defects poses an even greater treatment challenge. Options vary from impaction bone grafting of contained defects to large structural allografts for large vault defects, but graft subsidence still remains a problem.[13,25,26]

Numerous authors have classified glenoid bone defects. Antuña et al[2] classified defects as central, peripheral, and combined and graded the severity as mild, moderate, and severe. The authors proposed a 2-stage approach for severe central or combined defects.

The glenoid vault model[31] proposed by Williams and Iannotti emphasizes evaluation of the glenoid bone stock remaining and use of the vault for fixation of the glenoid component. The authors subclassified defects as subchondral, vault, and rim and modified Antuña's classification, providing suggestions for management of defects.

Sirveaux et al[28] classified glenoid defects in cuff tear arthropathy in the coronal plane. Frankle et al,[10] using 3-dimensional (3D) computed tomography (CT) reconstructions, have detailed the various patterns of glenoid erosion in cuff tear arthropathy. Normal glenoids were found in 62.5% of patients, whereas 37.5% of patients had abnormal glenoids. Altered glenohumeral mechanics contributed to the development of anterior, posterior, superior, and global defects. In the presence of large bone defects, the authors highlighted that the central glenoid axis can be used only in normal or superiorly eroded glenoids. In the other forms of erosion, the scapula spine axis may need to be used.

The current classification systems, although they describe the bone loss well, do not provide the surgeon with an intraoperative tool to address the bone loss and do not provide guidelines for a successful single-stage procedure in patients with significant bone loss. In addition, in revision cases, the defect left to manage intraoperatively may be different from the one highlighted by the preoperative imaging. More important, preoperative imaging may not help ascertain the size of the residual glenoid defect in the setting of a revision shoulder arthroplasty. We propose a classification system guiding intraoperative decision-making for the management of the glenoid defects.

The aim of our study was to evaluate the clinical and radiologic outcome of single-stage and 2-stage glenoid bone grafts in patients undergoing RSA with severe glenoid bone loss.

Materials and methods

This is a retrospective case series of patients who underwent glenoid bone grafting with RSA.

Selection of patients

Between 2001 and 2010, there were 94 patients undergoing RSA with significant bone loss requiring major glenoid bone grafting. This constituted 9% of the total number of RSAs performed (94/1075) during this time. There were 20 men and 74 women. Mean age was 73.0 years (34.5-8.6 years). RSA was performed for cuff tear arthropathy in 29.3%, failed prior arthroplasty in 27.2%, chronic dislocation in 21%, and post-traumatic cases in 17.4%.

Preoperative evaluation

All the patients underwent a true glenohumeral anteroposterior (AP) radiograph with the arm in neutral position (true AP radiograph), an axillary radiograph, and a scapular Y view. CT scan with 3D reconstruction was obtained and evaluated for the site and extent of the glenoid bone loss, which was subclassified on the basis of our classification system. Size of the necessary bone graft was calculated, and optimal baseplate position was templated. Care was taken to note whether a long central peg glenoid baseplate would be required.

Surgical technique

A standard deltopectoral approach was performed in all the cases. The humeral head is cut and preserved for bone grafting. In cases of revision, the humeral component is left in situ to prevent an iatrogenic fracture of the proximal humerus, and the glenoid is attended to first. Subscapularis peel is performed and the muscle tagged for later reinsertion. The axillary nerve is palpated, and in revision cases, the nerve is visualized to know its course around the glenoid neck. A complete capsulotomy is performed. The glenoid labrum and osteophytes are resected, and complete exposure of the glenoid face and the anterior neck and base of the coracoid is attained. In revision cases, the glenoid component or baseplate is removed. The residual bone stock is now evaluated and the glenoid bone loss classified.

Since 2001, the senior author's classification system has guided the management of glenoid defects at our institution. This