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The effect of proximal humeral bone loss on revision reverse total shoulder arthroplasty

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Background: Revision shoulder arthroplasty can be complicated by osseous and soft tissue deficiencies. Proximal humeral bone loss can result in diminished implant stability and reduced functional outcomes, and some studies have advocated the use of humeral allograft in this setting. This study compares the outcomes of revision reverse total shoulder arthroplasty (RTSA) in patients both with and without proximal humeral bone loss.

Methods: During a 6-year period, 32 patients were revised to RTSA for failed shoulder hemiarthroplasty. Proximal humeral bone loss was found in 16 patients, with an average loss of 36.3 mm (range, 17.2-66 mm). Patients were followed up an average of 51.2 months with the American Shoulder and Elbow Surgeons score, Simple Shoulder Test score, visual analog scale score for pain, subjective outcome ratings, and radiographs.

Results: Significant improvement was found for average American Shoulder and Elbow Surgeons score (30.7 to 66.8), Simple Shoulder Test score (1.6 to 5.3), visual analog scale score (6.0 to 2.6), and forward flexion (51° to 100°) but not for external rotation (15° to 19.1°). No difference was demonstrated for functional or subjective outcomes compared with patients with intact humeral bone, except for active motion. On radiographic examination, 3 patients demonstrated humeral-sided loosening. Five complications were noted in patients with humeral bone loss.

Conclusion: Revision RTSA can provide successful outcomes in the presence of proximal humeral bone loss without the use of allograft. Implant stability may be improved by the use of a cemented long-stem monoblock humeral prosthesis in revision settings.

Level of evidence: Level III, Retrospective Cohort Design, Treatment Study.

Keywords: Proximal humeral bone loss; revision reverse total shoulder arthroplasty; failed shoulder arthroplasty; allograft-prosthesis composite

The prevalence of shoulder arthroplasty has continued to increase in the past decade, and projected estimations reveal a growth rate that exceeds lower extremity joint replacement.[13,18] The increased number of shoulder

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replacements, though, will result in a proportional burden of revision cases. Shoulder arthroplasty can fail from either osseous or soft tissue deficiencies and result in pain, instability, hardware failure, infections, or loss of function.[15,22,24,27] Failure can result from either a single cause or, as in a majority of patients, a combination of factors.[4,16,17,33] This makes revision shoulder arthroplasty technically demanding, and it is demonstrated by reported outcomes to be inferior to primary shoulder arthroplasty.[1,8,19,30,31]

Identifying the cause of reconstruction failure can potentially optimize outcomes after revision surgery.[26] Dines et al[15] performed an outcomes analysis of shoulder arthroplasty and found that results could be predicted on the basis of the indication for the revision procedure, with soft tissue deficiencies producing inferior results. One potential factor that can affect preoperative planning for revision cases is proximal humeral osseous deficiency.[12,20,21,33] Proximal humeral bone loss can result from prior surgeries, infection, or complex proximal humerus fractures in which the tuberosities progress to nonunion, malunion, or resorption.[5] The loss of humeral bone stock can affect component fixation as well as disrupt the insertion of rotator cuff muscles.[12,14]

Reverse total shoulder arthroplasty (RTSA) has been effective in treating failed shoulder arthroplasty with soft tissue or bone loss because of its increased constraint and diminished reliance on an intact rotator cuff.[3,20,23,31] This implant, though, relies on a preserved humeral bone stock for implant fixation, rotational stability, and soft tissue attachments to improve function and stability postoperatively.[10,12,28,32] The loss of proximal humeral bone and associated soft tissue structures can thus play a pivotal role in a patient's results and has led some to advocate the use of allograft-prosthesis composites.[10,20] The goal of this study was to compare the outcomes for revision RTSA with and without proximal humeral bone loss. In addition, we compare the results of revision reverse shoulder arthroplasty in the setting of proximal humeral bone loss without the use of allograft to current literature.

Materials and methods

This study was a retrospective case series of prospectively collected data. During a 6-year period from 2004 to 2010, 34 patients (22 women, 12 men) with a mean age of 70 years (range, 53-87 years) were treated for failed shoulder arthroplasty with a single-stage conversion to a reverse shoulder prosthesis (Delta Extend; DePuy, Warsaw, IN, USA). The study was part of an Institutional Review Board–approved prospective database collection, and all enrolled patients provided informed consent for the follow-up examinations and use of their data. Two patients without proximal humeral bone loss were lost to follow-up; attempts were made to contact them, but they were unable to be reached, leaving 32 patients in the study. The initial diagnosis for implantation of the 32 hemiarthroplasties was either a proximal humerus fracture (11) or rotator cuff tear arthropathy (21). Failure of the arthroplasty resulted from pain, progressing glenoid arthrosis, diminished function, or instability. All patients failed to respond to attempted conservative treatment consisting of physical therapy and activity modification. All revision procedures were performed by the senior author (M.A.W.).

Patients were followed up clinically and radiographically for an average of 51 months (range, 24-130 months). Proximal humeral bone loss was identified in 50% (16 of 32) of the revision RTSAs, with the initial diagnosis consisting of proximal humerus fracture in 10 patients and rotator cuff tear arthropathy in 6 patients. The inclusion criteria for the study included any failed shoulder arthroplasty with pain or limited function that had failed nonoperative management, a functioning deltoid, and minimum 2-year follow-up. Exclusion criteria were a nonfunctioning deltoid, infection, and inability to complete 2 years of follow-up.

Clinical assessment

Patients were evaluated clinically with the use of the American Shoulder and Elbow Surgeons (ASES) score, Simple Shoulder Test (SST) score, and visual analog scale (VAS) score for pain. Scales for rating subjective outcomes were used to determine if there was sensation of instability, pain with active motion, and pain at rest. Range of motion was measured for forward flexion, external rotation, and internal rotation. Internal rotation was determined by the most proximal spinal level that the patient could reach.

Radiographic assessment

All patients were evaluated with radiographs consisting of anteroposterior, scapular Y, internal and external Grashey, and axillary views. Preoperative radiographs were evaluated for instability, glenoid bone loss, glenoid arthrosis, proximal humeral bone loss, position of humeral head, and condition of the tuberosities. Glenohumeral subluxation was evaluated with regard to direction and the amount of translation of the center of the prosthetic head relative to the center of the glenoid, as described by Rispoli et al.[25] Glenoid bone loss was determined by the use of the intraoperative classification by Antuña.[2] Proximal humeral bone loss was calculated on postoperative radiographs by the method described by Budge et al.[7] The condition of the tuberosities was evaluated for presence of malunion, nonunion, or resorption.

Postoperative radiographs were evaluated for humeral loosening by the classification of Gruen et al[16] adapted to the shoulder and classified according to width (<2 mm or >2 mm). Loosening was defined as displacement of the humeral component between the time of the initial postoperative radiograph and the most recent follow-up or if radiolucency >2 mm was present in more than 3 zones. The glenoid component was assessed for the presence of scapular notching according to the Sirveaux-Nerot grading system.[29] Any radiolucent lines around the glenoid screws, central peg, or baseplate were classified according to their width (<2 mm or >2 mm). Loosening was considered to be present if the glenoid component had migrated, as demonstrated by shift, tilt, or subsidence, or if complete radiolucency >2 mm was present in each zone. Instability was classified as present or absent. Acromial fractures and locations were noted to involve either the acromion body or scapular spine. Heterotopic bone located on the inferior glenoid was identified and recorded.