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ORIGINAL ARTICLE

Posterior glenoid bone grafting in total shoulder arthroplasty for osteoarthritis with severe posterior glenoid wear

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Background: Total shoulder arthroplasty (TSA) in cases with posterior wear can be addressed by eccentric reaming of the anterior glenoid or by augmenting the posterior glenoid with bone grafting or augmented glenoid implants. We report the results of TSA with posterior glenoid bone grafting (PGBG) with humeral head autograft in patients with shoulder osteoarthritis and severe posterior glenoid wear.

Methods: A retrospective review of cases from 2004 to 2014 revealed 34 patients. Preoperative and postoperative radiographs were evaluated for glenoid version and humeral head subluxation as well as component loosening. Patient-reported outcomes were compared preoperatively and postoperatively. Complications and reoperations were also evaluated.

Results: Of the 34 patients, 28 (82.4%) were available at a minimum of 2 years' follow-up. PGBG corrected glenoid retroversion from $-28° \pm 4°$ preoperatively to $-4° \pm 2°$ ($P < .001$). Humeral head subluxation also improved after PGBG with respect to the scapular axis and to the midglenoid face ($P < .001$). Radiographic analysis revealed all PGBGs had incorporated. Radiographically, 3 patients (10.7%) had a total of 5 broken or displaced screws. In addition, 3 patients (10.7%) had a broken metal marker in the center peg of the glenoid component. No patients required component revision surgery by final follow-up. Only 1 reoperation occurred for capsular release. Patients showed significant improvements in all patient-reported outcomes.

Conclusion: Patients undergoing primary TSA with humeral head autograft PGBG showed significant improvements in glenoid version, humeral head subluxation, patient-reported outcomes, and range of motion at an average of 4 years' follow-up. There was a low revision rate and a high rate of graft incorporation.

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

Keywords: Posterior glenoid bone loss; total shoulder arthroplasty; posterior glenoid bone grafting; humeral head autograft; glenoid wear; glenoid augmentation

Primary osteoarthritis in the shoulder is a debilitating condition for patients, severely limiting their ability to participate in activities of daily living. Total shoulder arthroplasty (TSA) offers patients pain relief and increased range of motion and activity level, with an overall implant survivorship estimated at greater than 85%.[27] Glenoid component failure is

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the most common complication after TSA, with contributing factors including aseptic loosening, component malpositioning, altered joint reactive forces, and insufficient bony support for the component. The degenerative wear pattern of osteoarthritis in the shoulder is frequently characterized by posterior glenoid bone erosion, which results in an increase in glenoid retroversion.[13,28]

Glenoid posterior wear patterns can increase the retroversion angle, result in medialization of the joint line, decrease glenoid vault volume, decrease glenohumeral contact area, and increase contact pressures, thus jeopardizing the long-term component functioning.[11,22] Varying degrees of posterior humeral head subluxation can also accompany the increased retroversion.[2,6,8,20,32] This condition can be further exacerbated by posterior capsular laxity or insufficiency, which can lead to further shoulder posterior extrusion outside the confines of the glenoid. If severe posterior glenoid bone loss is not corrected during a TSA, then the probability of glenoid loosening and instability can be dramatically increased.[4,11,30]

Glenoid bone loss with resultant retroversion of components presents a unique but not uncommon challenge to surgeons. Walch et al[32] classified glenoid bone loss according to the pattern and magnitude of posterior bone erosion that are present. This classification system is beneficial because it allows one to determine how significant the defect is and what surgical interventions may be necessary to re-create normal glenoid anatomy and version. In addition, advanced imaging including computed tomography (CT) scans with 3-dimensional reconstruction can help surgeons to understand the degree of bone loss, degree of retroversion, and amount of humeral head displacement.

In cases with posterior wear, the defect can be addressed by tackling the dilemma by either "lowering the front" or "raising the back." When a large defect is present, eccentric anterior glenoid reaming can lower the front to re-create normal version; however, this can result in inadequate bone support, increasing the risk of incomplete component seating and glenoid vault shortening and penetration.[9,12,27,30] Incomplete seating can also lead to eccentric loading of the implant, increasing stresses at the implant-bone interface, compromising overall stability.[8,19,32] In most cases the posterior glenoid wear pattern is in the posterior-inferior aspect of the glenoid and not a symmetrical or uniform wear pattern.[16-18]

Conversely, when large posterior defects are present, a posterior glenoid bone graft can be used to re-create normal anatomic glenoid version by raising the back. Posterior bone grafting can help to correct retroversion, restore bone stock, and provide a biological basis for healing and can prevent component penetration of the glenoid vault. In addition, bone grafting re-establishes a more "normal" joint position by avoiding medialization, normalizing mechanics and forces about the shoulder, and decreasing the risk of posterior subluxation.[22,30] However, few studies have evaluated the longevity of this option, the outcomes, and the effect on range of motion.[10,15,20,25,29] This article will discuss the surgical technique and results in 28 patients who were treated with posterior glenoid bone grafting (PGBG) with humeral head autograft in conjunction with implantation of a TSA.

Methods

Patient selection

A retrospective review of cases from 2004 to 2014 revealed 34 consecutive patients who underwent primary TSA with PGBG with humeral head autograft for primary shoulder osteoarthritis with severe posterior glenoid wear. The total number of TSA cases performed during this period was 325. In all patients, nonoperative management had failed, including activity modification, oral anti-inflammatories, and in some cases, physical therapy or intra-articular cortisone injections. The inclusion criteria involved glenoid retroversion such that the senior author's assessment was that asymmetrical anterior reaming would result in excessive removal of bone stock and increase the risk of perforation. The range of retroversion in this series was −42° to −20°; thus, we did not have any cases with −15° or less, which has been discussed as a threshold in anatomic studies. Indications for considering PGBG were patients with glenohumeral arthritis, an intact rotator cuff, and significant glenoid posterior wear. Revision and reverse TSAs, as well as surgical indications other than primary osteoarthritis with posterior glenoid wear, were excluded. Patients with missing radiographs were excluded. Only patients with a minimum of 2 years' follow-up were included.

Radiographic measurements

All patients underwent preoperative and postoperative radiographs including a true anteroposterior view of the glenohumeral joint, scapular Y view, and axillary lateral view. Axillary radiographs were evaluated for glenoid version with respect to the scapular axis as per the method of Friedman et al[6] (Fig. 1, *A*). Advanced imaging studies—either magnetic resonance imaging or CT scans—were obtained preoperatively (Fig. 1, *B*). Although the ideal for this study would have been postoperative advanced imaging (CT), this imaging was not obtained postoperatively in that the patients were functioning well and there was no clinical indication for such imaging. The goal was to make the measurements as translational as possible so that the surgeon in the office could correlate preoperative and postoperative plain films in the office. Axillary radiographs were also evaluated for humeral head subluxation relative to the scapular axis and the glenoid face.[24] Postoperative radiographs were evaluated for glenoid version and humeral head subluxation in the same fashion. Postoperative radiographs at most recent follow-up were assessed for PGBG healing, hardware complications, and component loosening. The senior author, a fellowship-trained shoulder surgeon with over 20 years in practice, evaluated all imaging. All measurements were performed in a digital imaging environment with angle measurement software. Incorporation of the graft was evaluated on the axillary radiograph, with comparison to serial radiographs, for osteolysis, lucent lines, or position change.

Surgical technique

TSA is performed through a deltopectoral approach with standard humeral preparation. After glenoid exposure, PGBG is performed