Augmented Glenoid Component for Bone Deficiency in Shoulder Arthroplasty

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Published online: 8 January 2008
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Abstract Asymmetric posterior glenoid wear caused by degenerative glenohumeral arthritis can be addressed by several techniques during total shoulder arthroplasty. The purpose of this study was to evaluate the midterm outcome of a posterior augmented glenoid component to determine the clinical and radiographic outcome, including complications and the need for revision surgery. Between 1995 and 1999, 13 patients (14 shoulders) underwent a shoulder arthroplasty with an augmented glenoid component to treat posterior glenoid bone deficiency. All 14 shoulders had advanced osteoarthritis. The minimum followup for these 13 patients was 2 years (mean, 5 years; range, 2–8 years). The mean age of these patients was 66 years at the time of surgery (range, 52–78 years). The mean active elevation was 160° (range, 120°–180°) and external rotation was 56° (range, 30°–90°). According to a modified Neer result rating system, 36% of patients had an excellent result, 50% a satisfactory result, and 14% an unsatisfactory result. Our results suggest patients undergoing total shoulder arthroplasty with an asymmetric glenoid component for osteoarthritis achieve satisfactory mid-term pain relief and improvement in function; however, instability is not always

corrected. The advantage of this component seems marginal, and its use has been discontinued.

Level of Evidence: Level IV, retrospective review. See Guidelines for Authors for a complete description of levels of evidence.

Introduction

Degenerative arthritis that results in asymmetric posterior glenoid wear presents potential challenges for the surgeon, including bone deficiency, joint subluxation, and soft tissue laxity or contracture. Options to address the bone deficiency include asymmetric reaming of the anterior glenoid to try to create neutral glenoid alignment, glenoid bone grafting, or use of an asymmetric glenoid component (Fig. 1). Asymmetric reaming of the glenoid has its limitations due to concerns of shortening the length of the glenoid vault and compromising keel or peg fixation, narrowing of the glenoid fossa compromising support for the glenoid component and medial offset of the joint line altering biomechanics and compromising arm elevation. The results of glenoid bone grafting as reported by Hill and Norris [3] and Steinmann and Cofield [7] have expressed concerns related to inconsistent graft incorporation, inability to fully correct joint subluxation, and an increased rate of periprosthetic lucency and glenoid component loosening. Therefore, there has been interest in the use of a posterior augmented glenoid component for the treatment of substantial posterior glenoid wear.

We asked whether this method of addressing glenoid bone deficiency provides a satisfactory clinical and radiographic outcome with a low frequency of complications and the need for revision surgery.

Each author certifies that he or her institution has approved the reporting of these cases, that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained.

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Fig. 1 View from bottom to top of the polyethylene glenoid component, keel type, with asymmetrical thickness of the polyethylene front and back. There were three component sizes, and the height difference between the front and the back was 0.44, 0.51, and 0.58 inches, respectively. This change corrected the slope of the glenoid bone by approximately 4°.

Materials and Methods

We retrospectively reviewed 13 patients (14 shoulders) with glenohumeral arthritis and posterior glenoid deficiency treated with a shoulder arthroplasty utilizing a posterior augmented glenoid component between January 1, 1995 and December 31 1999. No patients with this procedure were excluded. All patients had severe shoulder pain that failed to respond satisfactorily to nonoperative treatment. All patients had complete preoperative evaluation, operative records, and a minimum 2 year followup period (mean 5 years; range, 2.1–8 years) or until the time of the revision surgery.

The preoperative, initial postoperative, and most recent radiographs were evaluated by three observers (JWS, RSR, RHC) and consensus reached in the case of disagreements. Shoulder radiographs were made using a 40° posterior oblique radiograph with external rotation of the humerus, a 40° posterior oblique radiograph with internal rotation of the humerus, and an axillary radiograph. Preoperative radiographs were available for 13 shoulders, initial postoperative radiographs were available for 14 shoulders, and most recent radiographs were available for 12 shoulders with a mean follow-up of 3.9 years (range, 1–8 years).

The mean age of the patients at the time of arthroplasty was 66 years (range, 52–78 years). There were 12 men (13 shoulders) and one woman. The diagnosis was osteoarthritis in all patients. A deltopectoral exposure was used in all shoulders. The senior author (RHC) performed the shoulder arthroplasty in all cases. There were no shoulders with full thickness rotator cuff tears. The glenoid components were all Cofield 2TM keeled all-polyethylene cemented components with a posterior augmentation (Smith and Nephew, Inc, Memphis, TN) (Fig. 1). Glenoid preparation was altered to both match the posterior glenoid wear and accept the asymmetrically thickened glenoid component. Instead of performing the reaming in the neutral position, the reaming was performed with 5° of posterior inclination to generally match the amount of glenoid bone deficiency. We moved the centering hole for preparation of the keel slightly posterior to allow for more length of the keel as it would abut the anterior cortex of the glenoid neck. This allowed for secure keel placement and fixation and matched the asymmetric surface of the glenoid component with a thicker mass posteriorly correcting the posterior angulation to a neutral or near neutral position. The humeral component was uncemented in all shoulders and had 10 sizes of modular humeral heads (Smith and Nephew, Inc). In addition, all patients had laxity of the posterior shoulder capsule and rotator cuff addressed by adjustment of humeral head size and lengthening of the contracture of the anterior capsule and subscapularis. This was achieved by releasing the anterior shoulder capsule from the glenoid rim and by releasing the subscapularis tendon and anterior shoulder capsule from the humeral neck and reattaching them 1 cm more medial to their usual insertion site (Fig. 2). The limb was then protected in a shoulder immobilizer or sling for 5–6 weeks. A passive motion program for the shoulder was started on day 1 within limits determined at the time of surgery. The active assisted motion program started at 5 to 6 weeks, as did isometric strengthening. At 2 to 3 months, stretching and more progressive strengthening began.

The clinical outcome was assessed by the patients' interpretation of their pain and satisfaction, by clinical assessment of active range of motion, and by the modified Neer result rating. Pain was graded on a one through five scale as previously published by Neer et al. [4] and Cofield [1]: one point if there was no pain, two points for slight pain, three points for pain after unusual activities, four points for moderate pain, and five points for severe pain. Active elevation and external rotation were recorded in degrees. Internal rotation was graded according to the posterior spinal region the thumb could reach. A modified Neer result rating system was used [6]. To be considered an excellent result, patients had to have no pain or slight pain, had to be satisfied with the procedure, achieve at least 140°

Fig. 2A–F Preoperative radiographs demonstrate (A) typical posterior subluxation and (B) severe glenohumeral arthritis in the shoulder of a 69-year-old man who underwent a total shoulder arthroplasty with a posterior augmented glenoid component. The patient had severe pain, external rotation of 10°, and active elevation of 75°. (C) Radiographs taken at the first postoperative visit (D) show the shoulder 3 months after surgery. Radiographs obtained 6 years after surgery demonstrate (E) mild posterior-superior subluxation and (F) moderate glenoid wear. The patient had no pain, external rotation of 30°, and active elevation of 150°.

of active elevation, and external rotation of at least 45°. Patients were considered to have a satisfactory result if they had no pain, slight pain, or moderate pain only with vigorous activities, were satisfied with the procedure, and had at least 90° of active elevation and external rotation of at least 20°. If any of the criteria were not met, the result was unsatisfactory. Patients who underwent additional operative procedures were considered to have an unsatisfactory result.

The radiographs of the patients who had a total shoulder arthroplasty were reviewed to determine the presence of glenohumeral subluxation, periprosthetic radiolucency,

shift or subsidence in the position of the humeral component, and migration or tilt of the glenoid component. Periprosthetic lucency was graded as Grade 0 if there was no radiolucent line, Grade 1 if the line was 1 mm wide or less and incomplete, Grade 2 if the line was 1 mm wide and complete, Grade 3 if the line was 1.5 mm wide and incomplete, Grade 4 if the line was 1.5 mm wide and complete, and Grade 5 if the line was 2 mm wide and complete. 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 or the glenoid component. It was recorded as none,

mild if there was less than 25% translation, moderate if there was 25% to 50% translation, and severe if there was more than 50% translation. Glenoid component migration and tilt was either present or absent. Humeral component subsidence and tilt was either present or absent [5].

Data are presented as number and percent for categorical variables and mean and range for continuous variables. A paired t-test was performed to compare preoperative versus postoperative ordinal and continuous measurement, such as pain, abduction, internal rotation and external rotation. The alpha level was set at 0.05 for significance.

Results

All patients had moderate or severe pain (Grade 4 or 5) prior to surgery. At the most recent followup, two patients (one with the anterior dislocation) had Grade 4 pain, four patients had Grade 3 pain, one patient (two shoulders) had Grade 2 pain, and six patients had Grade 1 pain. Pain rating decreased ($p = 0.0001$) from 4.3 preoperatively to 2.1 postoperatively. Among the 13 patients, four felt they were much improved, six felt they were improved (7 shoulders). Two felt they were the same (one with moderate pain and the one with anterior dislocation), and one patient felt he was worse due to moderate post-operative pain. Active abduction improved from a mean of 99° (45 to 150°) to 160° (120 to 180°), p value of 0.0001. External rotation increased from a mean of 35° (0– 75°) to 56° (30– 90°), with a p value of 0.057. Median range of internal rotation was the ability of the thumb to reach the sacrum preoperatively and L3 postoperatively, with a p value of 0.12. Applying the Neer result rating, there were five excellent, seven satisfactory, and two unsatisfactory results. The reason for an unsatisfactory result was moderate pain in both shoulders. Preoperative radiographs revealed three shoulders with moderate and one shoulder with severe posterior subluxation. At the most recent radiographs, four of the 12 shoulders that could be evaluated radiographically had more than mild glenohumeral subluxation. Three shoulders had moderate posterior subluxation, one shoulder had severe anterior subluxation. All of the shoulders with postoperative subluxation had some degree of subluxation present prior to surgery. Of note, the shoulder with severe anterior subluxation postoperatively had moderate posterior subluxation prior to surgery. This patient had Parkinsonism and sustained anterior instability resulting in dislocation, treated with closed reduction, followed by immobilization and physical therapy. There was no periprosthetic lucency in four shoulders, periprosthetic lucency was grade 1 in seven shoulders and grade 5 in one shoulder, and the glenoid component had shifted in position. This shoulder also had moderate posterior subluxation, and this

glenoid component was considered radiographically loose. There was no periprosthetic humeral lucency in eleven shoulders and periprosthetic lucency of grade 1 in one shoulder. No humeral component had tilted or subsided in its position. No shoulder underwent revision surgery.

Discussion

There has been little information available to guide clinical decision-making in regard to shoulder arthroplasty with substantial posterior glenoid bone deficiency. If one is to realign the glenoid to its normal position, consideration can be made for reaming the high side of the glenoid to align the glenoid properly, add a bone graft to the deficient area or use a special type of component or some combination of the above. We asked whether this method of addressing glenoid bone deficiency provides a satisfactory clinical and radiographic outcome with a low frequency of complications and the need for revision surgery.

Our study is limited to a small number of patients (13) and shoulders (14). Further, we can provide only midterm followup at this time. The patients were selected based upon specific criteria and the results might not apply to other indications. We used older categorical ratings which might not relate to validated contemporary outcome measures. Further, we had no validated measure of patient satisfaction.

We reviewed a small number of patients who had placement of an asymmetrically thick glenoid component to help realign the glenoid to a more normal facing angle with the prosthetic part thickness addressing the bone deficiency and the asymmetrical articulation surface realigning the glenoid to a neutral or near neutral position. It was also anticipated that this adjunct to shoulder arthroplasty would facilitate correction of joint subluxation and subsequent progressive shoulder instability. As with other types of total shoulder arthroplasty, unless there is a complication, these patients would be expected to achieve a substantial reduction in pain, and improvement in movement and function, patient satisfaction, and only occasional radiographic changes indicative of loosening. These things all occurred in this group of patients. The few previous reports of patients with posterior deficiency have involved small groups of patients (eg, 17 to 24) with short followup (eg, 2 to 6 years) [2, 3], and none have attempted to use a posterior augmented glenoid component to achieve recentering of the glenohumeral articulation.

Due to the asymmetrical glenoid wear, there is a high rate of glenohumeral subluxation into the area of bone erosion. All but one of the patients had posterior subluxation present on the preoperative radiographs. This could be corrected by realigning the glenoid component and

adjusting capsule tension or the use of modular humeral heads and selected releases. This combined technique was used in 10 of the 12 shoulders that could be evaluated radiographically at the time of followup assessment. At most recent followup, three patients continued to have posterior subluxation; however, there were also two patients that had developed anterior subluxation after the arthroplasty procedure. This finding is likely attributed to a weakened subscapularis muscle. The patient with severe anterior subluxation experienced an anterior shoulder dislocation in the perioperative period. Among patients with posterior humeral head subluxation, posterior capsular laxity is frequently present. Generally, this can be corrected; however, residual posterior subluxation may occur. Important for shoulder arthroplasty in general, careful soft tissue balancing and adequate tissue release are critical to performing a successful arthroplasty among patients with posterior glenoid deficiency. There was only one glenoid with major lucency of the glenoid component.

This reflects a high degree of success in correction of the posterior glenoid wear and posterior humeral subluxation by a combination of treatment measures used in this paper, including the use of the asymmetrically thick glenoid component. However, the role of this type of component and its contribution to the overall correction of glenoid

bone wear and humeral subluxation seemed marginal, leading us to discontinue the use of this component in this setting. It did not seem to create any negative problems but probably did not contribute measurably to the outcomes achieved in this patient group.

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