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The effects of glenoid wear patterns on patients with osteoarthritis in total shoulder arthroplasty: an assessment of outcomes and value

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Background: Despite the success of total shoulder arthroplasty (TSA), concerns remain about the longevity of the implant, in particular, glenoid component survivorship. The purpose of this study was to determine whether preoperative glenoid wear patterns affect clinical outcomes and value in patients undergoing TSA.

Methods: A comparative cohort study was conducted of 309 patients with a total of 344 TSA procedures, performed for primary glenohumeral osteoarthritis. Computed tomography scans were obtained in all patients, with preoperative glenoid wear pattern characterized as either concentric (n = 196; follow-up time, 49.2 months) or eccentric (n = 148; follow-up time, 52.3 months) according to a modified Levine classification. A clinical, radiographic, and economic assessment was performed between the 2 wear patterns.

Results: There was no significant difference in American Shoulder and Elbow Surgeons (ASES) score in the concentric group (80.8 ± 20.8) compared with the eccentric group (77.6 ± 21.2) at final follow-up ($P = .159$). Range of motion and final visual analog scale for pain score were similar between the 2 groups. Radiographic evidence of gross glenoid loosening was significantly lower in the concentric group [11 of 195 (5.6%)] compared with the eccentric group [18 of 147 (12.2%)] ($P = .030$). Revision rates were similar between the concentric group [4 of 195 (2.0%)] and the eccentric group [3 of 147 (2.0%)]. A value assessment also showed no significant difference between the concentric and eccentric groups [concentric 26.1 vs. eccentric 25.5 (ΔASES score/$10,000 hospital cost) ($P = .479$)].

Conclusions: Similar clinical results and value can be expected with both concentric and eccentric glenoid wear patterns in TSA. Concerns arise, however, as the eccentric group demonstrated a more than 2-fold increased rate of glenoid component loosening compared with the concentric group.

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This study was determined to be exempt from review by the Western Institutional Review Board.

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

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Total shoulder arthroplasty (TSA) has become a successful procedure for the treatment of primary glenohumeral osteoarthritis (GHOA), restoring function and alleviating pain. Despite successful outcomes and increasing numbers of TSAs performed, the number of revisions is also steadily rising.[8] Thus, significant research is being devoted to implant survivorship.[21] In review of the literature, Bohsali et al[2] found that implant loosening is the most common complication in TSA, primarily due to glenoid-sided failure. With the costs of medicine rising, glenoid component survivorship appears to be a significant key in providing favorable long-term results and improved value for our patients.

Multiple causes have been attributed to glenoid-sided failure, including asymmetric joint wear, rotator cuff failure, glenoid dysplasia, infection, poor surgical technique, and implant design.[3,4,6,14,17,19,20,22,30] It has been proposed that arthritic glenohumeral joints exhibiting preoperative static subluxation and asymmetric glenoid wear will lead to inferior clinical outcomes and higher rates of failure after TSA.[19,24,27,28] This is thought to occur when the glenoid bone cannot be sufficiently prepared to create a symmetric surface for proper component seating or if excessive subchondral bone is reamed away to obtain a symmetric glenoid.[29] Also, if asymmetric soft tissue contractures are inadequately corrected at the time of surgery, continued asymmetric contact on the glenoid component will lead to the ''rocking-horse phenomenon'' and eventual glenoid-sided failure.[11,27]

The purpose of this study was to examine the effects of preoperative glenoid wear patterns on clinical outcomes, glenoid component survivorship, cost, and value after TSA. We hypothesized that arthritic shoulders demonstrating eccentric glenohumeral wear characteristics before TSA would lead to inferior clinical outcomes, reduced glenoid component survivorship, and worse value.

Materials and methods

Patient population

Between 2004 and 2011, 403 unconstrained TSAs were performed at a single institution by the senior author (M.A.F.) for the diagnosis of end-stage primary GHOA. Our inclusion criteria consisted of a complete preoperative assessment and a minimum of 2 years of clinical and radiographic follow-up of the affected shoulder. Subjects with a diagnosis other than primary GHOA or <2 years of follow-up were excluded from the study. A cohort of 309 patients with a total of 344 TSAs (35 bilateral TSAs) met our inclusion and exclusion criteria and was analyzed for the study. The mean age of all patients at the time of surgery was 67 years (range, 37-88 years). Our study cohort was composed of 195 male and 149 female shoulders. The average duration of follow-up was 50.7 months (range, 24-110 months).

Preoperative glenoid evaluation

A computed tomography (CT) scan (GE LightSpeed QXi, axial 1.25-mm slices; GE Healthcare, Waukesha, WI, USA) of the shoulder (standardized position to the CT gantry) was performed in the supine position as part of the preoperative protocol. This scan was analyzed for glenoid wear, version, and humeral head subluxation in relation to the glenoid.

Before commencing the study, we selected the Walch and Levine classifications to evaluate glenoid wear.[23,27] The Walch classification divides wear into 5 types on the basis of the symmetry and amount of wear as well as glenoid retroversion. The Levine classification is binary, classifying glenoid wear as either concentric or nonconcentric. We modified the Levine classification for this study by using preoperative CT assessment in the axial plane, instead of plain radiographs and intraoperative assessment, which was used originally. This modified system classifies glenoid wear as either concentric or eccentric, defined as follows (Fig. 1). Concentric glenoid wear demonstrates a symmetric distribution of bone sclerosis, cyst formation, and bone erosion. It is considered uniconcave only and is independent of glenoid version and glenohumeral subluxation measurements, as shoulders with increased native retroversion or subluxation are still considered concentric as long as there are no signs of asymmetric wear. Eccentric glenoid wear is characterized by an asymmetric distribution of bone sclerosis, cyst formation, and bone erosion. Wear is independent of glenoid version and glenohumeral subluxation measurements. It can demonstrate biconcave bone erosion. For the purposes of analogy, Walch type A1/A2 glenoids were considered concentric, whereas type B1/B2 glenoids were considered eccentric. Type C glenoids were categorized as either concentric or eccentric on the basis of the presence of asymmetric glenoid wear.

We performed interobserver and intraobserver reliability testing on the Walch and modified Levine classifications to determine which to use for our study. Three independent observers (B.M.S., J.L.C., S.T.M) classified 27 randomized, blinded CT images of patients who had primary GHOA with both the Walch and modified Levine classifications after a teaching session and washout period of 4 weeks before reclassification. By use of Cohen's κ, the Walch classification demonstrated a lower interobserver and intraobserver reliability ($\kappa = 0.54$, $\kappa = 0.62$) compared with the modified Levine classification ($\kappa = 0.60$, $\kappa = 0.70$). As such, we decided to use the modified Levine classification for our study.

Two orthopedic research fellows (S.T.M. and J.L.C.) separately analyzed the preoperative CT scans of every patient and classified glenoid wear by the modified Levine classification. In instances in