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J Bone Joint Surg Am. 2007;89:1284-1292. doi:10.2106/JBJS.E.00942

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By Joseph R. Lynch, MD, Amy K. Franta, MD, William H. Montgomery Jr, MD, MPH, Tim R. Lenters, MD, Doug Mounce, and Frederick A. Matsen III, MD

Investigation performed at the Department of Orthopaedics and Sports Medicine, University of Washington, Seattle, Washington

Background: Active and young individuals with glenohumeral arthritis who are treated with total glenohumeral arthroplasty are at risk for loosening or wear of the prosthetic glenoid component. This study tests the hypothesis that patients with severe glenohumeral arthritis have improvement in self-assessed shoulder comfort and function at two to four years after treatment with the combination of humeral hemiarthroplasty and concentric glenoid reaming without tissue or prosthetic component interposition.

Methods: Thirty-seven consecutive patients (thirty-eight shoulders), with a mean age of fifty-seven years, who were managed by one surgeon were enrolled in this prospective study. The procedure consisted of an uncemented humeral hemiarthroplasty combined with reaming of the glenoid to a diameter 2 mm larger than that of the prosthetic humeral head. The duration of follow-up ranged from two to four years (average, 2.7 years) for thirty-five shoulders. Self-assessed comfort and function was documented with use of the Simple Shoulder Test, and radiographs were evaluated.

Results: Thirty-two shoulders demonstrated improved comfort and function according to patient self-assessment, one demonstrated no change, and two had worse function following the procedure. The total number of Simple Shoulder Test functions that could be performed increased from 4.7 (of a possible 12.0) before surgery to 9.4 at the time of the final follow-up. The patients demonstrated significant improvement in ten of the twelve individual functions of the Simple Shoulder Test ($p < 0.022$ to $p < 0.00001$). With the numbers studied, gender, diagnosis, age, glenoid wear, and preoperative glenoid erosion did not significantly affect final shoulder function or overall improvement. The range of motion was significantly improved for all individuals ($p < 0.00001$). Radiographically, twenty-two patients had a joint space between the glenoid bone and the humeral prosthesis at the time of final follow-up. These shoulders had significantly better function than those without a preserved joint space ($p < 0.017$). There were no surgical complications and no revisions to total shoulder arthroplasty.

Conclusions: At a minimum follow-up of two years, a selected series of patients who had humeral hemiarthroplasty with concentric glenoid reaming for the treatment of glenohumeral arthritis showed significant improvement in self-assessed shoulder comfort and function. Further study, however, is needed before routine application of this procedure can be recommended.

Level of Evidence: Therapeutic Level IV. See Instructions to Authors for a complete description of levels of evidence.

Disclosure: The authors did not receive any outside funding or grants in support of their research for or preparation of this work. One or more of the authors, or a member of his or her immediate family, received, in any one year, payments or other benefits in excess of $10,000 or a commitment or agreement to provide such benefits from a commercial entity (DePuy endowed chair). No commercial entity paid or directed, or agreed to pay or direct, any benefits to any research fund, foundation, division, center, clinical practice, or other charitable or nonprofit organization with which the authors, or a member of their immediate families, are affiliated or associated.

Despite advances in implant technology and surgical technique, the long-term results of total glenohumeral arthroplasty can be compromised by delayed loosening of the glenoid component, fragmentation, wear, and instability[1-13]. The risk of prosthetic failure continues for the duration of the life of the patient after total shoulder arthroplasty[14]. Surgical revision after glenoid component failure is often challenging and may be unsuccessful because of scarring and irreversible glenoid bone loss[1,7,12,15-24]. On the other hand, humeral hemiarthroplasty alone has been shown to yield inferior functional results when the glenoid surface is compromised[25]. Earlier studies on hip and knee arthroplasty have provided encouraging evidence that reamed bone articulating with a convex metal prosthesis can remodel to a functional and durable arthroplasty concavity, sometimes lasting over four decades[26-34]. Notably, the majority of so-called mold arthroplasty failures of the hip were on the femoral side and not on the acetabular side of the articulation[35-38]. An analysis of pelvic specimens retrieved post mortem revealed that the concave acetabular joint surface was often covered with a smooth regenerated surface and had reestablished homogeneous and stable subsurface bone[38]. Moreover, the tissue covering the acetabular concavity was found to resemble dermis and meniscus in terms of glycosaminoglycan content[39].

We previously explored the ability of a reamed mammalian glenoid to undergo molded healing while in contact with a metal humeral prosthesis[40]. In a canine model with use of a metal humeral hemiarthroplasty, we demonstrated that reamed glenoid bone became completely covered with conforming, living, and securely attached fibrocartilaginous tissue at twenty-six weeks after surgery. The bone beneath this regenerated biological joint surface was uniform in structure and density, suggesting an even distribution of the load applied by the prosthetic humeral head[40]. We subsequently defined a reproducible technique applicable to human shoulders that involves spherically reaming the glenoid subchondral bone to a concavity concentric with the humeral head prosthesis[41-43]. We initiated a prospective clinical study of this technique—humeral hemiarthroplasty combined with concentric glenoid reaming—to test the hypothesis that this approach to shoulder arthroplasty can significantly improve the comfort and function of arthritic shoulders as indicated by the primary outcome variable of patient self-assessment with use of the Simple Shoulder Test (SST).

TABLE I Demographic Characteristics of the Thirty-Four Patients

No. of shoulders	35
Age* *(yr)*	57 ± 9.8 (35-80)
Gender	
Men†	31 (91%)
Women	3 (9%)
Side *(no. of shoulders)*	
Right	18 (51%)
Left	17 (49%)
No. of shoulders with history of surgery	13 (37%)

*The values are given as the mean and the standard deviation, with the range in parentheses. †One man had bilateral involvement.

Materials and Methods

Between December 2000 and February 2003, we performed a consecutive series of thirty-eight humeral hemiarthroplasties combined with concentric glenoid reaming in thirty-seven patients who met the selection criteria detailed below (Fig. 1). All patients provided informed consent. The operations, postoperative follow-up, and rehabilitation were carried out and coordinated by an individual surgeon (F.A.M.), and the study was performed with the approval of our institutional human subjects review committee[41,43]. Two patients (two shoulders) were lost to follow-up. One additional patient (one shoulder) was contacted but declined to provide further follow-up information for personal reasons having to do with his insurance claim. These three individuals were excluded from the final analysis. Thirty-four patients (thirty-five shoulders; 92%) were followed for a mean (and standard deviation) of 2.7 ± 0.5 years (range, two to four years). The demographic characteristics of the study population are summarized in Table I.

The patients documented their shoulder function preoperatively and postoperatively using the SST, a standardized questionnaire assessing twelve shoulder functions (for a maximum score of 12). This self-administered questionnaire has been demonstrated to have discriminate and construct validity, to be reproducible, and to be responsive to changes in

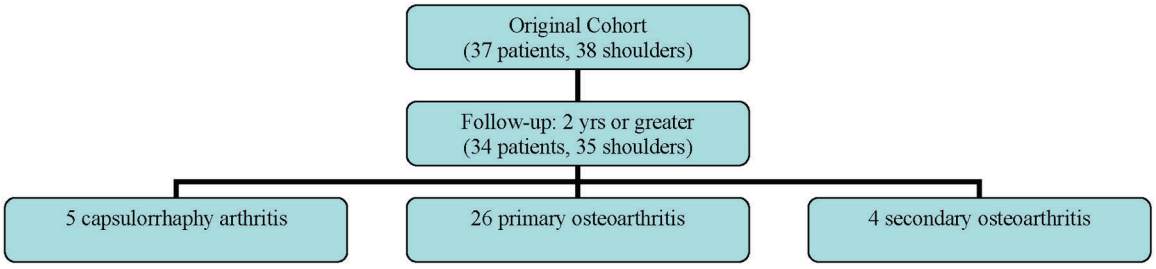

Fig. 1

A prospective cohort study consisting of a consecutive series of patients treated with humeral hemiarthroplasty and concentric glenoid reaming between December 2000 and February 2003.

shoulder function resulting from therapeutic interventions[44-55]. Clinical evaluations, including range of motion and radiographic data, were recorded for the initial and most recent follow-up visits.

Patient Selection

Patients were offered humeral hemiarthroplasty and concentric glenoid reaming if they met each of the following conditions: (1) they had substantial functional compromise of the shoulder attributable to glenohumeral degenerative joint disease; (2) they were either under sixty-five years of age or had activity expectations that included work or recreation involving impact, heavy loads, or prolonged physical activity; (3) they had no previous shoulder arthroplasty; (4) no inflammatory arthropathy; (5) no evidence of infection; (6) they did not smoke or use major narcotic or chronic steroid medication; (7) they were well motivated; (8) they accepted the possibility that the outcome might not be as rapid and as comfortable as with a total shoulder arthroplasty; (9) they accepted the risk that the procedure might need to be converted to a total shoulder arthroplasty if the outcome was unsatisfactory; (10) they had no major comorbidities, such as cardiac, renal, hepatic, pulmonary, metabolic, and emotional conditions; and (11) they had sufficient glenoid bone stock, rotator cuff function, and stability, in the judgment of the surgeon, to allow for a successful procedure. The final decision was made by the patient who, after personal discussion with the surgeon, balanced the established outcomes of hemiarthroplasty and total shoulder arthroplasty by the same surgeon[25,47,50,56-59] against his or her desire to avoid the risks of delayed failure of the glenoid component.

Radiographic Data

Adequate preoperative, postoperative, and follow-up radiographs were available for thirty-four (97%) of the thirty-five shoulders. One patient, who was living outside the continental United States, received follow-up care from a local surgeon who was unable to provide radiographic data concerning the patient. Routine follow-up radiographs included an anteroposterior radiograph and an axillary lateral radiograph, and these were evaluated by four observers (J.R.L., A.K.F., T.R.L., and W.H.M Jr.). A consensus among the reviewers was reached on the presence of each of the following radiographic characteristics: medial glenoid erosion, eccentric glenoid wear, loss of the joint space, postoperative progression of medial glenoid erosion or eccentric glenoid wear, subchondral sclerosis, regenerated joint space, humeral component loosening, and humeral component register. Register refers to the relationship between the humeral articular surface and the glenoid. Proper register is said to occur when the humeral articular surface seats fully in the glenoid both with the arm in adduction and in 45° of abduction.

Operative Technique

With the patient under adequate anesthesia with muscle relaxation and placed in a low beach-chair position, a straight skin incision is made over the deltopectoral groove. Adhesions in the humeroscapular motion interface are released bluntly from the axillary nerve medially, beneath the coracoacromial arch to the axillary nerve laterally. The subscapularis is incised sharply from its insertion onto the lesser tuberosity, preserving the maximal possible length of the tendon. A complete release of the subscapularis tendon is then performed.

The medullary canal of the proximal part of the humerus is entered with a high-speed burr at the anteroposterior midpoint of the humeral head just medial to the rotator cuff insertion and posterior to the bicipital groove. Progressively larger humeral reamers are introduced into the medullary canal through this hole until endosteal cortical contact is achieved. The humeral head is resected at 45° with the long axis of the reamer and in 30° of retroversion, while the rotator cuff insertion is protected. The canal is subsequently broached to receive the trial prosthesis.

The glenoid is then exposed, and the anterior capsule is released from the glenoid labrum preserving the glenoid attachment of the labrum and its contribution to the glenoid concavity. The inferior glenohumeral ligament complex is preserved if there is posterior glenoid wear or posterior humeral subluxation; otherwise, the release is continued around the glenoid in an extralabral fashion. Any remaining cartilage and marginal osteophytes are then removed from the glenoid. A starting hole is then made at the center of the glenoid face with use of a small burr. A 6-mm hole is made along this centerline starting at the burred center point to receive the nub of the reamer.

A spherical reamer is selected with a diameter of curvature that is 2 mm larger than the planned prosthetic humeral head. Placing the nub of the reamer into the central glenoid drill-hole ensures concentric reaming around the glenoid centerline[41,42]. Reaming is conservative, preserving as much bone stock as possible. It is continued only until a concentric spherical surface is achieved across the entire face of the glenoid. If the glenoid is biconcave with substantial posterior erosion, the crest between the two concavities is removed with a burr and the glenoid is then reamed in slightly more retroversion until a single concavity is achieved.

Trial humeral heads of different heights are then used to identify the implant that provides the desired kinematics (40° of external rotation, 50% posterior translation with a posteriorly directed translational force, and 60° of internal rotation with the arm in 90° of abduction). If necessary, bone is resected to ensure clearance between the adducted humerus and the inferior aspect of the glenoid. The head and body parts of the humeral trial component are assembled and inserted down the shaft to the depth that provides proper register such that the humeral articular surface is precisely centered in the reamed glenoid. Achieving proper register is critical because the margins of the reamed glenoid are not as forgiving as those of a prosthetic glenoid component. Once ideal prosthetic geometry and position are determined, six holes are drilled in the anterior aspect of the humeral neck near the cut surface and number-2 braided nonabsorbable sutures are

TABLE II Comparison of Self-Assessed Outcome After Humeral Hemiarthroplasty with Concentric Glenoid Reaming and Outcome After Total Shoulder Arthroplasty Performed by the Same Surgeon at the Same Institution

Characteristic/Function	Total Shoulder Arthroplasty* (n = 102)	Humeral Hemiarthroplasty and Concentric Glenoid Reaming (n = 35)
Gender		
Men	82 (80%)	32 (91%)
Women	20 (20%)	3 (9%)
Duration of follow-up *(yr)*	2.5 to 5	2 to 4
Age† *(yr)*	64 ± 10	57 ± 9.8
Shoulder function according to Simple Shoulder Test† (SST)		
Preoperative function (ISST)	4.2 ± 2.6	4.7 ± 2.4
Final function (FSST)	9.3 ± 3.1	9.4 ± 2.6
Change in function (DSST)	+ 5.1	+4.7
Significance of change *(p value)*	<0.0001	<0.00001
Shoulders with improved function following intervention according to patient	96 (94%)	33 (94%)
Shoulders with worse function following intervention according to patient	6 (6%)	2 (6%)
Likelihood of regaining a lost function	73% (582/797)	71% (181/256)
Likelihood of losing a function that was present before surgery	6% (26/427)	10% (17/164)
Significant improvement in shoulder function at time of final follow-up‡		
Able to place arm comfortably at side	Yes	Yes
Able to sleep comfortably	Yes	Yes
Able to tuck in back of shirt	Yes	Yes
Able to place hand behind head	Yes	Yes
Able to place coin at shoulder level	Yes	Yes
Able to lift 1 lb (0.5 kg) to shoulder level	Yes	Yes
Able to lift 8 lb (3.6 kg) to shoulder level	Yes	Yes
Able to carry 20 lb (9 kg) at side	Yes	No
Able to toss softball 20 yd (18.3 m) underhand	No	No
Able to toss softball 20 yd (18.3 m) overhand	Yes	Yes
Able to wash back of contralateral shoulder	Yes	Yes
Able to work full-time in regular job	Yes	Yes

*The data on the results of total shoulder arthroplasty are from a study by Fehringer et al.[47]. †The values are given as the mean and the standard deviation. ‡$P < 0.01$ for all improvements in the study by Fehringer et al., and $p < 0.022$ to $p < 0.00001$ for the improvements in the present study.

passed through the holes for later reattachment of the subscapularis. Cancellous autograft harvested from the resected humeral head is then impacted in the medullary canal of the humerus until a snug press-fit of the prosthesis is achieved[60,61]. The definitive humeral component (Global; DePuy, Warsaw, Indiana) is assembled and inserted. Clearance between the medial aspect of the humerus and the inferior part of the glenoid, component register, glenohumeral mobility, and stability are then verified. If there is a tendency for posterior subluxation when the humerus is flexed, a rotator interval closure is performed. The subscapularis is then repaired to the lesser tuberosity with use of the previously placed nonabsorbable sutures, and the wound is closed in layers over a drain.

Postoperatively, the involved arm is placed into a continuous passive motion machine in the recovery room so that the arm is slowly moved from internal rotation and adduction at the side to neutral rotation and 90° of flexion five times per minute. On the first postoperative day, the patient is instructed in assisted flexion to 140° and assisted external rotation to 20°. These exercises are performed five times a day by the patient with frequent checks by a physical therapist. External rotation isometric strengthening is also instituted while

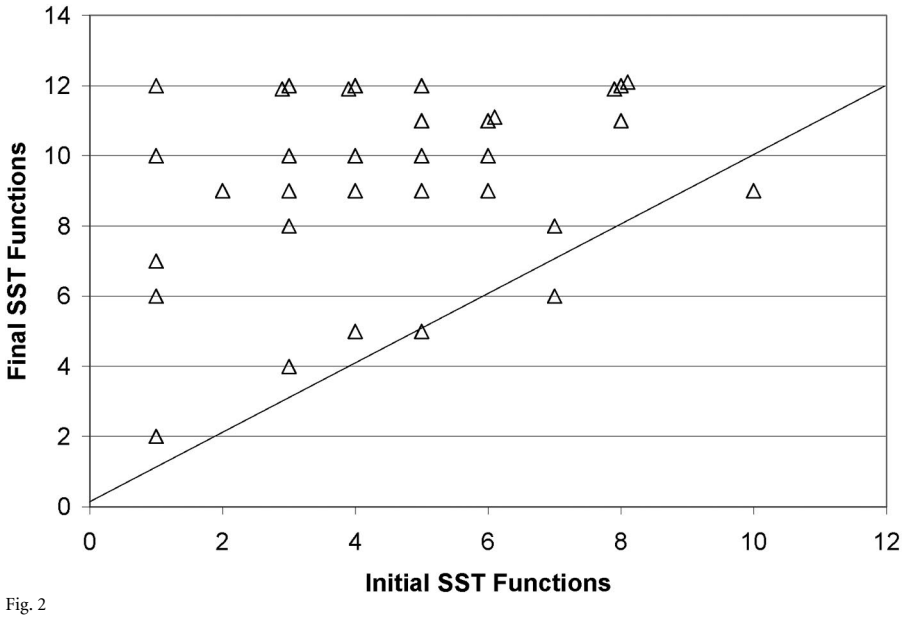

Fig. 2

The distribution of the patients with respect to initial shoulder function (ISST) and final shoulder function (FSST) as measured by the Simple Shoulder Test (SST). The line of identity (ISST = FSST) is shown. The individuals above the line demonstrated improvement in self-assessed shoulder function at the time of the final follow-up. The individuals on or below the line demonstrated no change or had worse self-assessed shoulder function.

the patient is in the hospital. Patients are discharged when they can comfortably demonstrate independence with this postoperative exercise regimen. The rehabilitation for the first six weeks is focused on maintaining glenohumeral flexibility through comfortable passive and active-assisted exercises. Supervised outpatient physical therapy is used as necessary to ensure maintenance of range of motion. Patients are restricted from lifting >1 lb (0.45 kg) with the involved extremity for six weeks after surgery. Additionally, patients are asked to avoid anti-inflammatory medications for six weeks following this procedure out of concern that these medications may impair the healing response. Formal rotator-cuff-strengthening against resistance is withheld until twelve weeks postoperatively to ensure secure healing of the subscapularis repair and early healing of the glenoid surface. Patients are encouraged to transition back into their recreational activities and other physical demands as long as such activities are comfortable and as long as they can maintain shoulder range of motion. No other limits are placed on their activities.

In this series of patients, anterior capsular releases were performed in all shoulders. Inferior and posterior capsular releases were performed on the fourteen shoulders without posterior glenoid wear. The twenty-one shoulders with posterior glenoid wear had only anterior capsular releases.

Data Analysis

The effectiveness of the procedure in restoring comfort and function of the shoulder was determined in a manner identical to that in our previous study, in which we used the SST as the primary outcome variable[47]. The self-assessed function at the time of final follow-up was recorded as the final SST (FSST). The difference in the SST (DSST) was the difference between the FSST and the initial SST (ISST) obtained preoperatively. Similarly, the change in the ability to perform each individual function of the SST was also determined. Preoperative range of motion and radiographic data were recorded for each patient and were compared with similar data recorded at the time of final follow-up. In addition, associations between preoperative and postoperative radiographic characteristics were evaluated with regard to the self-assessed outcome. The Student t test was performed on paired and unpaired continuous data. The McNemar chi-square test for paired observations was used to evaluate changes in individual shoulder functions[62]. Outcome measures were compared with the previously reported[47] functional results of patients treated with total shoulder arthroplasty by the same surgeon.

Results

The average initial self-assessed shoulder function (ISST) (and standard deviation) was 4.7 ± 2.4 of a possible twelve functions (Table II). At the time of final follow-up, self-assessed shoulder function (FSST) averaged 9.4 ± 2.6, representing a positive change (positive DSST) in shoulder function and comfort of 4.7 ± 2.9 ($p < 0.00001$). A table in the Appendix presents a summary of ISST, FSST, and DSST results distributed by age, diagnosis, and gender. Of the twelve individual SST functions, significant improvement ($p < 0.022$ to $p < 0.00001$) was demonstrated in ten: the ability to place the

arm comfortably at the side, to sleep comfortably, to tuck in back of shirt, to place the hand behind the head, to lift a coin, to lift 1 lb (0.5 kg), or to lift 8 lb (3.6 kg) to shoulder level, to throw overhand, to wash the back of the contralateral shoulder, and to work full time (see Appendix).

Among the thirty-five shoulders, there were a total of 420 potential shoulder functions (twelve each for thirty-five shoulders). Of the 256 shoulder functions that were absent for thirty-five shoulders preoperatively, 181 were regained. The overall likelihood of regaining a lost function was 71% (181/256). Similarly, of the 164 shoulder functions that were present preoperatively, seventeen were lost after surgery, making the overall likelihood of losing a function 10% (17/164). Two shoulders had a decrease in the total number of shoulder functions that could be performed (a negative DSST), and one shoulder demonstrated no change (ISST = FSST; Fig. 2). Preoperatively, the forward elevation and external rotation were a mean (and standard deviation) of 60° ± 45° and 14° ± 19°, respectively. These motions improved significantly ($p < 0.00001$) to a mean of 138° ± 19° of forward elevation and a mean of 42° ± 19° of external rotation at the time of final follow-up. These data are similar to the outcomes reported previously for total shoulder arthroplasty performed by the same surgeon[42].

The mean ISST was significantly worse for women (1.6) than for men (5.0) ($p < 0.02$). Similarly, patients with osteoarthritis resulting from a previous operation or injury demonstrated worse preoperative shoulder function (1.8) compared with those with primary osteoarthritis (4.7) ($p < 0.01$). With the numbers studied, the final shoulder function (FSST) and the change in shoulder function (DSST) were not significantly affected by age, gender, diagnosis, and the presence or absence of medial glenoid erosion, eccentric glenoid wear, or glenohumeral joint space on preoperative radiographs (see Appendix). Lastly, shoulder function at the time of the final follow-up was not different for shoulders that had previous surgery in comparison with those that had no previous surgery (9.4 for both groups).

Preoperatively, radiographs showed that twenty-six shoulders (74%) had complete absence of a glenohumeral joint space, twenty-one shoulders (60%) had eccentric glenoid wear, and twelve shoulders (34%) had medial glenoid

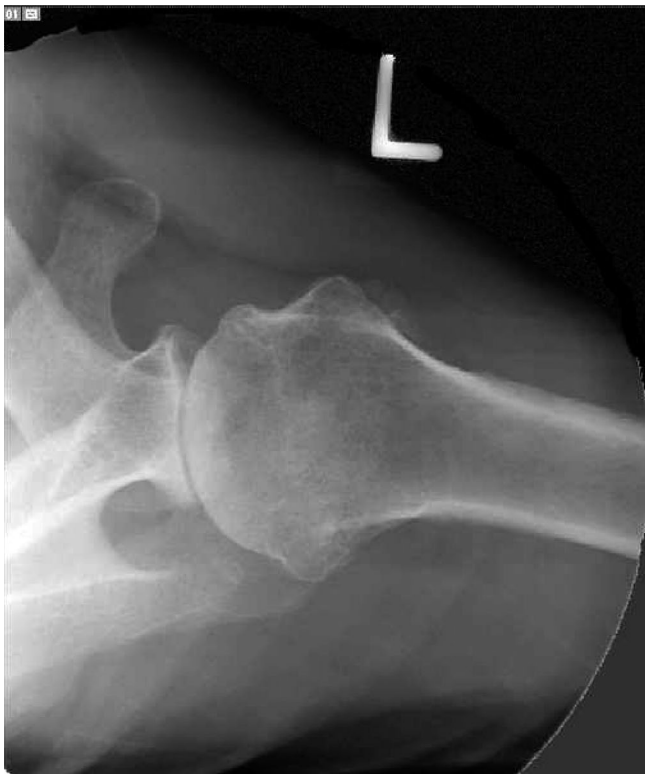

Fig. 3-A

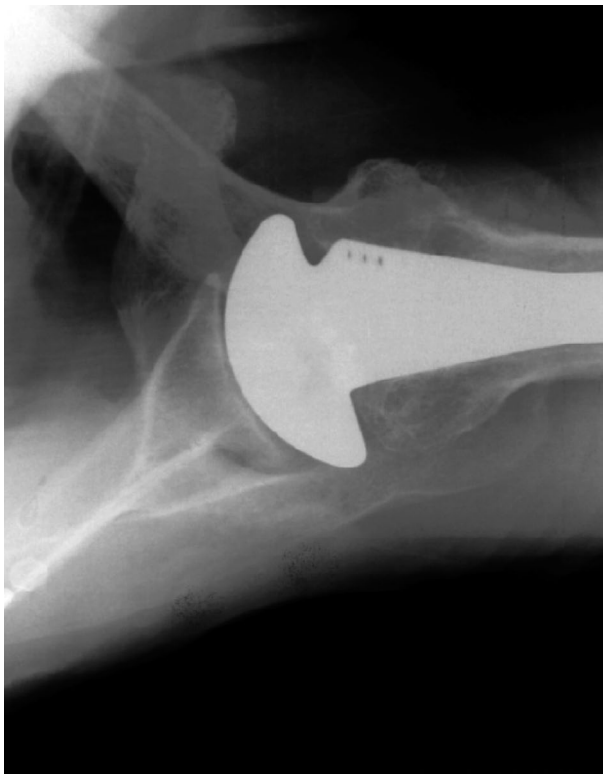

Fig. 3-B

Figs. 3-A and 3-B A sixty-four-year-old man with osteoarthritis of the left shoulder that was treated with humeral hemiarthroplasty and concentric glenoid reaming. **Fig. 3-A** Preoperative axillary radiograph demonstrates severe osteoarthritis and an eccentric glenoid with posteriorly directed glenoid wear. Preoperatively, this patient scored 8.0 of a possible 12.0 positive responses on the initial Simple Shoulder Test (ISST). **Fig. 3-B** A follow-up axillary radiograph, made three years postoperatively, demonstrates a definite lucency between the metal humeral prosthesis and the reamed glenoid bone, representing the regenerated joint surface. In addition, the glenoid surface is concentric without evidence of recurrent posterior glenoid wear. Self-assessed function as measured by the Simple Shoulder Test three years postoperatively was significantly improved (FSST = 11.0).

erosion. Among the twenty-one shoulders with an eccentrically worn glenoid, twenty had posterior glenoid wear. At the time of the final follow-up, radiographs showed that twenty-two shoulders had a definite lucency between the metal humeral prosthesis and the reamed glenoid bone (Figs. 3-A and 3-B). Self-assessed functional outcome at the time of final follow-up (FSST) was significantly greater for the individuals demonstrating a regenerated joint space compared with those who had no evidence of a regenerated joint space (10.1 and 8.2, respectively; $p < 0.017$). Patients with a concentric glenoid preoperatively demonstrated a greater improvement in self-assessed shoulder function (DSST) than did patients with an eccentric glenoid (5.7 and 4.0, respectively; $p < 0.045$). One shoulder had radiographic signs of humeral loosening, four demonstrated progressive medial glenoid erosion, and six demonstrated recurrent posterior glenoid wear. Radiographic results and their association with self-assessed functional outcome are shown in a table in the Appendix.

There were no surgical complications, no infections, and no episodes of instability. No shoulder in this series was revised to a total shoulder arthroplasty. One patient, however, underwent repeat concentric reaming of the glenoid eight months after the index procedure because of symptoms of persistent pain and stiffness. When presented with the alternatives, he did not wish to have a revision to a total shoulder arthroplasty but, rather, expressed a strong desire to have repeat capsular releases and repeat glenoid reaming. His overall shoulder function at fifty months after the original surgery and forty-one months after the repeat glenoid reaming was an FSST score of 12 of a possible 12.

Discussion

The present study is the first, as far as we know, to characterize the functional outcome of patients with severe glenohumeral arthritis who were managed with humeral hemiarthroplasty and concentric glenoid reaming. These results support the hypothesis that this technique can significantly improve the self-assessed comfort and function of patients at a minimum follow-up of two years. Overall, thirty-two shoulders had improved, one was unchanged, two had become worse, and three were lost to follow-up.

The two shoulder functions in the SST that did not demonstrate significant improvement were: (1) the ability to carry 20 lb (9 kg) comfortably at the side and (2) the ability to toss a softball 20 yards (18 m) underhand. Only three patients (9%) felt that they could not carry 20 lb (9 kg) comfortably preoperatively. Two of these three patients felt comfortable performing this function at the time of final follow-up, and no patient lost this function postoperatively. Of the seventeen patients who felt they could not toss a softball 20 yards (18 m) underhand preoperatively, ten felt that they could perform this function comfortably at the time of final follow-up. These data are similar to the outcomes reported previously for a series of patients who had total shoulder arthroplasty performed by the same surgeon (Table II)[47].

Previously published work regarding shoulder arthroplasty has demonstrated relationships between preoperative demographic and/or radiographic characteristics and patient outcome. Specifically, investigators have found an association between posterior glenoid wear and poorer functional outcome following humeral hemiarthroplasty[25,63-65]. In our series of patients treated with humeral hemiarthroplasty and concentric glenoid reaming, the final functional outcomes of shoulders with preoperative glenoid wear were not different from those without glenoid wear (9.2 and 9.6, respectively; $p = 0.36$). However, the individuals with a concentric glenoid preoperatively demonstrated significantly greater improvement in the SST than those with an eccentric glenoid preoperatively (5.7 and 4.0, respectively; $p = 0.045$). In addition, the current analysis demonstrated better functional outcomes in individuals who at the time of final follow-up had a definite lucency radiographically between the metal humeral prosthesis and the reamed glenoid bone, suggesting that a potentially regenerated joint surface, which can be visualized radiographically, predicts improved results from this procedure.

Some investigators have found that a preoperative diagnosis of secondary osteoarthritis can negatively affect shoulder function after arthroplasty[25,66-69]. Similarly, our patients with secondary osteoarthritis demonstrated significantly worse shoulder function preoperatively than did the patients with a diagnosis of primary osteoarthritis. Additionally, we found that women had significantly worse preoperative shoulder function than men. Despite these differences, patients from each of these groups appeared to demonstrate similar improvement in overall function at the time of final follow-up.

Sperling et al. provided what may be the longest duration of follow-up after shoulder arthroplasty[67,68]. In their series of 114 shoulder arthroplasties followed for a period of twenty years, they noted that an age of less than fifty years and a history of shoulder surgery (as well as a preoperative diagnosis of secondary osteoarthritis) had a strong association with an unsatisfactory outcome and an increased risk for revision surgery. Hettrich et al. also found that a history of surgery was associated with poorer functional outcome[25]. Among our patients treated with humeral hemiarthroplasty and concentric glenoid reaming, those with a history of shoulder surgery had outcomes identical to those without such a history (9.4 for both groups). Furthermore, in contrast to the report of Sperling et al., our results were not age-dependent.

This study should be viewed in light of several limitations, including: (1) the relatively short length of follow-up (mean, 2.7 years), which prevented us from defining the long-term durability of the functional improvement; (2) the limitation of treatment to a single procedure without a concurrent comparison group, which prevented us from making a prospective comparison with traditional hemiarthroplasty or total shoulder arthroplasty; and (3) the inclusion of only data from a single surgeon, preventing us from determining the generalizability of the results.

Despite these limitations, we conclude that, with a minimum two-year follow-up in this selected series of patients with severely arthritic shoulders, humeral hemiarthroplasty combined with concentric glenoid reaming significantly improved the self-assessed comfort and function of the shoulder without subjecting the patients to the risks of glenoid component failure. Further study, however, is needed before routine application of this procedure can be recommended.

Appendix

eA Tables showing detailed patient demographic data, Simple Shoulder Test results, and radiographic results are available with the electronic versions of this article, on our web site at jbjs.org (go to the article citation and click on "Supplementary Material") and on our quarterly CD-ROM (call our subscription department, at 781-449-9780, to order the CD-ROM). ■

Joseph R. Lynch, MD
William H. Montgomery Jr, MD, MPH
Tim R. Lenters, MD
Doug Mounce
Frederick A. Matsen III, MD
Department of Orthopaedics and Sports Medicine, University of Washington Medical Center, 1959 N.E. Pacific Street, Box 356500, Seattle, WA 98195. E-mail address for F.A. Matsen III: matsen@u.washington.edu

Amy K. Franta, MD
Aspen Orthopaedic and Rehabilitation, 19475 West North Avenue, Suite 201, Brookfield, WI 53045

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