Shoulder hemiarthroplasty with concentric glenoid reaming in patients 55 years old or less

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\textbf{Background:} Glenohumeral arthritis in younger individuals is challenging because of the complex pathology, need for extended durability, and high expectations of the patients. Humeral hemiarthroplasty combined with concentric glenoid reaming is a surgical option for the management of glenohumeral arthritis that avoids the risks of glenoid component failure and avoids the challenges of tissue interposition. The results of this procedure in young patients have not been previously reported.

\textbf{Methods:} Sixty-five shoulders in patients who were 55 years old or less at the time of surgery underwent humeral hemiarthroplasty combined with concentric glenoid reaming and were followed for a minimum of 2 years or until the time of revision surgery. Patient self-assessments of shoulder comfort and function were compared before and after surgery. For 22 of these shoulders, standardized radiographs were available for follow-up evaluation.

\textbf{Results:} Nine shoulders required revision surgery. These shoulders had 3 ± 3 prior surgeries, in comparison to 1 ± 1 prior surgeries for the unrevised group. For the 56 unrevised shoulders, the number of Simple Shoulder Test functions that could be performed improved from a mean of 4.1 before surgery to a mean of 9.5 at an average follow-up of 43 months (range, 24-85) ($P < .001$). For the 22 shoulders with radiographic follow-up, medial glenoid erosion averaged 1.1 mm (range, 0.0-6.3 mm) at an average of 44 months after the procedure.

\textbf{Conclusion:} In selected patients 55 years or younger with glenohumeral arthritis, this procedure can provide significant improvement in self-assessed shoulder comfort and function.

\textbf{Level of evidence:} Level IV, Case Series, Treatment Study.

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\textbf{Keywords:} Hemiarthroplasty; concentric glenoid reaming; shoulder arthritis; young patient; self-assessed comfort and function

The management of glenohumeral arthritis in younger patients is particularly challenging in contrast to that in older individuals because of: 1) the need for greater durability of the reconstruction; 2) higher expectations on the part of the patient; and 3 the greater prevalence of types of arthritis more complex than primary osteoarthritis.\textsuperscript{26}
Surgical decision-making is further complicated because patient satisfaction with shoulder arthroplasty in younger patients has been reported to be inferior to that reported in older individuals.28,29

While there is evidence that total shoulder arthroplasty provides better pain relief than hemiarthroplasty alone,4,11,15 concerns over glenoid component loosening and wear19 in young active patients has tempered the use of total shoulder arthroplasty in this patient population. The challenges of reconstructing the young arthritic shoulder has led surgeons to explore soft tissue interposition, such as with capsule or meniscal allograft rather than prosthetic glenoid arthroplasty;14,30 however, the durability of these procedures is uncertain.9,30

In addition to hemiarthroplasty, total shoulder arthroplasty and soft tissue interpositional arthroplasty, a 4th type of reconstruction for glenohumeral arthritis has been described: the combination of humeral hemiarthroplasty with concentric glenoid reaming without interposition, avoiding the risks potentially associated with polyethylene glenoid components on one hand and the complexities of soft tissue interposition on the other.6,7,16 The goals of this study were to identify the revision rate, the change in self-assessed comfort and function, and the amount of medial migration in a group of patients 55 years old or less with glenohumeral arthritis treated with hemiarthroplasty and concentric glenoid reaming at a minimum follow-up of 2 years.

Materials and methods

Patient selection

In our practice we present the possibility of hemiarthroplasty with concentric glenoid reaming to highly motivated and informed patients who desire to avoid the potential risks of wear and loosening that are associated with glenoid components.19 We do not usually offer this procedure to patients with inflammatory arthropathy, smokers, or those taking medications that may interfere with healing of the reamed glenoid bone.18 Additionally, patients taking daily narcotics are usually not offered this surgical option because of the potential problems with postoperative pain control that may interfere with their ability to follow through with the requisite rehabilitation program. We are cautious about offering this procedure to patients with depression, workers’ compensation claims, or with uncertain commitment to the rehabilitation process.6 Prospective candidates are counseled that pain relief and improvement in function may take longer to achieve and may be less complete than with conventional shoulder arthroplasty.5 They are also counseled that revision surgery may be necessary, possibly including insertion of a glenoid component.

Operative technique

The surgical technique has been described in detail previously.6,7,16 Briefly, the humerus is prepared to receive a conventional stemmed humeral component. The anterior capsule is released from the glenoid labrum to the level of the anterior inferior glenohumeral ligament if significant posterior glenoid wear or posterior subluxation is present; otherwise, in stiff shoulders, the release may be continued around the entire glenoid leaving the labrum attached to the glenoid. Spherical reaming of the glenoid is then performed around an axis fixed in the center of the glenoid fossa using a reamer with a diameter of curvature 2 mm larger than the planned prosthetic humeral head. Larger reamer diameters (54 or 58 mm) are preferred to allow for maximal articular contact area. If a biconcave glenoid is present, the crest between the 2 concavities is removed with a burr and the glenoid is reamed until a smooth, single concavity is present to optimize the stability and the contact area provided by the glenoid. The humeral component is placed following impaction autografting of the medullary canal with cancellous bone harvested from the resected humeral head.12,20 Upon insertion of the humeral component, particular attention is directed at the alignment of the humeral component with the reamed glenoid and avoidance of abutment between the humeral bone and glenoid in positions of adduction or external rotation. The humeral head prosthesis is chosen so that its diameter of curvature is 2 mm smaller than that of the reamed glenoid. The humeral head prosthesis thickness is selected so that forward elevation to 150° is easily achieved and so that the arm can be passively internally rotated to 60° while in 90° of abduction. If the humeral head tends to drop backward more than 50% on passive elevation, a rotator interval plication is considered to control the unwanted posterior translation. Because it is recognized that this procedure may increase the chances of postoperative stiffness, it is only used when substantial “drop back” is observed at surgery.

After surgery, assisted motion is implemented by continuous passive motion while the patient is in the medical center and by home exercises afterwards. The patient achieves 150° of forward elevation prior to discharge and is instructed to maintain at least this degree of motion throughout the recovery period. Strengthening exercises are instituted after 6 weeks and once comfortable range is achieved.

Data collection

Between 2000 and 2008, 214 patients (231 shoulders) underwent humeral hemiarthroplasty combined with concentric glenoid reaming by the senior author.7,25 Our intention was to study the improvement in self-assessed comfort and function of 72 shoulders in 71 patients 55 years or younger that were more than 2 years out from the surgical procedure. The upper age limit of 55 years of age was chosen so that the study group was comparable to a recent report examining a similar patient population having their arthritis treated with soft tissue interposition.30 Of the 72 shoulders potentially available for study, 7 did not have adequate follow-up data and 9 required revision surgery. Of the remaining 56 shoulders, 31 had primary degenerative joint disease, 16 capsulorrhaphy arthropathy, 5 failed hemiarthroplasties, 2 post-traumatic arthritis, 1 inflammatory arthritis, and 1 glenoid dysplasia. Most of these shoulders had prior surgery (Table I). None of the patients were noted to have full-thickness rotator cuff tear at the time of surgery.

Functional evaluation of patients

The Simple Shoulder Test (SST) is a validated measurement tool22 that was used for functional evaluation of patients in this study.
This patient self-assessment tool was selected because many of our patients live a long way from our center, so that a return for 2-year in-person follow-up proved prohibitive for many of them; furthermore, clinical assessments performed near their homes proved unreliable. Therefore, the use of evaluation tools such as the Constant or ASES instruments would have resulted in a substantial loss of cases to follow-up. The initial SST was obtained prior to surgery, and the final SST was obtained at the most recent follow-up. All initial scores were obtained from patients directly answering the questions in paper format. Thirty eight of the final scores were obtained from patients directly answering the questions in paper format and 18 were obtained via a phone interview. Minimum follow-up was 2 years following the procedure (average 43 +/- 18 months).

**Radiographic evaluation of patients**

We attempted to obtain standardized preoperative and postoperative radiographs on each of the shoulders including axillary lateral and anteroposterior radiographs in the plane of the scapula.\(^2^1,2^5\) Initial radiographs were available for all shoulders. However, many of our patients live far away from our center and obtaining satisfactory postoperative radiographs on their shoulders proved difficult, even when we sent requests to their local physicians. Satisfactory radiographs were available at least 2 years following the procedure or just prior to revision surgery for 22 of the shoulders with the average length of radiographic follow-up for these shoulders of 45 +/- 17 months.

Glenohumeral subluxation was evaluated on the axillary lateral radiograph with respect to the direction and amount of translation of the humeral head relative to the center of the glenoid, as described by Iannotti and Norris.\(^1^3\) Glenohumeral joint space was measured in millimeters on the axillary lateral radiographs. Sclerosis of the subchondral bone of the glenoid was noted to be present or absent. Radiographs were evaluated by 2 reviewers (MDS and AMC) and consensus was obtained for all of the parameters.

**Statistical analysis**

For assessment of the significance of change between the initial and final SST scores, a 2-tailed, paired \(t\) test was used. The results were considered significant when \(P < .05\).

**Table I** Patient demographic data

<table>
<thead>
<tr>
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<th>Nonrevised</th>
<th>Revised</th>
<th>Follow-up less than 2 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of patients</td>
<td>55</td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td>Number of shoulders</td>
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<td>9</td>
<td>7</td>
</tr>
<tr>
<td>Age</td>
<td>48 ± 8 (range, 22-55)</td>
<td>48 ± 5 (range, 40-55)</td>
<td>46 ± 10 (range, 27-55)</td>
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<tr>
<td>Male</td>
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</tr>
<tr>
<td>Female</td>
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<td>0</td>
<td>0</td>
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<tr>
<td>History of previous shoulder surgery</td>
<td>38 (68%)</td>
<td>8 (90%)</td>
<td>4 (57%)</td>
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<tr>
<td>Number of previous surgeries</td>
<td>1 ± 1 (range, 0-3)</td>
<td>3 ± 3 (range, 0-7)</td>
<td>1 ± 1 (range, 0-3)</td>
</tr>
<tr>
<td>Initial SST</td>
<td>4.1 ± 2.5</td>
<td>2.6 ± 2.7</td>
<td>2.6 ± 2.4</td>
</tr>
</tbody>
</table>

SST, Simple Shoulder Test.

**Results**

**Clinical**

All shoulders had significant impairment of shoulder comfort and function prior to surgery (Table I). For the 56 unrevised shoulders with a minimum of 2-year follow-up, the average initial SST was 4.1 +/- 2.5. For the revised shoulders, the initial SST was 2.6 ± 2.7; for the shoulders with inadequate follow-up, the initial SST was 2.6 ± 2.4 (Fig. 1). For the 56 unrevised shoulders with a minimum of 2-year follow-up, the average final SST was 9.5 +/- 2.9 at an average follow-up of 43 ± 18 months (range, 24-85). The average increase in the SST was 5.4 ± 3 \((P < .001)\). Fifty-three of the shoulders functioned better following the procedure than they did before the surgery, while 1 functioned the same and 2 functioned worse than before surgery, according to patient self-assessed comfort and function. These outcomes were similar to those reported for shoulders that underwent total shoulder arthroplasty by the same surgeon who performed the procedures in this report (Table II).\(^1^0\) The 48 patients with a final SST of 6 or more had an average initial SST of 4.4 ± 2.5 and an average improvement of 6.1 ± 2.5, whereas the 8 patients with a final SST of less than 6 had an initial SST of 2.1 ± 1.8 and an average improvement of only 1.3 ± 2.2.

**Radiographic**

For the 22 shoulders with radiographic follow-up, 16 had centered humeral heads and 6 had subluxated humeral heads before surgery. At final follow-up, all 22 shoulders had centered humeral heads. Preoperatively, 5 had mild, 7 had moderate, and 10 had severe posterior glenoid erosion. At final follow-up, 8 had mild, 8 had moderate, and 6 had severe posterior glenoid erosion, according to the method of Iannotti and Norris.\(^1^3\) None of the patients with mild posterior glenoid erosion preoperatively progressed to moderate or severe glenoid erosion postoperatively, whereas 1 of the patients with moderate glenoid erosion preoperatively progressed to severe...
posterior glenoid erosion at most recent follow-up. Five patients had severe posterior glenoid erosion that persisted from preoperative to the time of most recent follow-up. Preoperatively, the average glenohumeral joint space was 0.3 ± 0.7 mm. The average glenohumeral joint space at the initial follow-up (4-6 weeks postoperatively) was 0.4 ± 0.5 mm. The average glenohumeral joint space at final follow-up was 1.0 ± 0.6 mm ($P = .02$). Final radiographs revealed definite sclerosis of the subchondral bone of the glenoid in 14 of 22 patients (Figure 2, A, B). The final SST score for those with definite sclerosis was 8.3 ± 4 and 8.1 ± 4 for those without definitive sclerosis. For those 22 shoulders in which radiographic follow-up was available, medial glenoid erosion averaged 1.1 mm (range, 0.0-6.3) at an average of 44 months after the procedure.

Revision surgery

Nine of the 65 shoulders required additional surgery: 4 were converted to total shoulder arthroplasty for refractory pain (at 12, 19, 21 and 38 months postoperatively); 2 were treated with repeat reaming of the glenoid for residual pain (at 8 and 55 months postoperatively); 1 was converted to a reverse shoulder arthroplasty (at 29 months postoperatively) for severe, refractory posterior instability; 1 underwent resection of unwanted bone contact (at 10 months postoperatively); and 1 required a single-stage revision for infection secondary to a hand cellulitis (at 15 months postoperatively). It is of note that the revised shoulders had an average of 3 ± 3 surgeries prior to our procedure, whereas the unrevised shoulders had 1 ± 1 prior procedures. The revised shoulders had average initial SST scores averaging 2.6 ± 2.7, while the unrevised shoulders had average initial SST scores averaging 4.1 ± 2.5. The ages for the 2 groups were the same: 48 years (Table I).

Patients lost to follow-up

Two-year follow-up could not be obtained on 7 of the 65 shoulders, despite repeated attempts on our part. These patients had an average age of 46 ± 10 years, preoperative SST scores of 2.6 ± 2.4, and 1 ± 1 prior surgeries (Table I).

Discussion

Shoulder arthroplasty in older individuals generally has a favorable outcome; however, the outcomes for younger individuals have been less favorable. The literature suggests that the results in this age group need to be considered separately from those in older patients. Sperling et al reviewed 78 Neer hemiarthroplasties and 36 Neer total shoulder arthroplasties performed in patients aged 50 years or younger. Sixty-two hemiarthroplasties and 29 total shoulder arthroplasties had complete preoperative evaluation, operative records, and a minimum 15-year follow-up or follow-up until revision were included in the clinical analysis. Among the hemiarthroplasties, there were 6 excellent, 19 satisfactory, and 37 unsatisfactory results. Among total shoulder arthroplasties, there were 6 excellent, 9 satisfactory, and 14 unsatisfactory results. The number of unsatisfactory results in this series underscores the challenges associated with treating glenohumeral arthritis in younger individuals.
Prosthetic glenoid component failure is the most common complication following total shoulder arthroplasty and accounts for the majority of unsatisfactory results. Soft tissue interpositional arthroplasty, with anterior capsule, autogenous fascia lata, or Achilles tendon allograft, has been suggested as an alternative to placement of a polyethylene glenoid component in young, active patients. While the early results of soft tissue interposition seemed promising, a more recent study by Elhassan et al reported an overall failure rate of 92% utilizing this technique. Wirth has recently reported on 30 patients younger than 55 years of age with glenohumeral arthritis that were treated with hemiarthroplasty and lateral meniscal allograft resurfacing of the glenoid. The average number of SST functions increased by 4.6 following this procedure (2.7 +/- 2.2 preoperatively to 7.3 +/- 3.3 postoperatively). By comparison, the average number of SST functions increased by 5.4 in our current series (4.1 +/- 2.5 preoperatively to 9.5 +/- 2.9 postoperatively) despite not using any type of interpositional material.

Wirth et al evaluated 57 patients that underwent isolated humeral hemiarthroplasty for glenohumeral arthritis. They reported a mean SST score of 9.4 at final follow-up, while ours was 9.5 in the present series. These authors emphasize the importance of soft balancing including sufficient capsular releases and selection of appropriate component sizes. In their series, nonconcentric glenoids were treated with reaming along the glenoid centerline to correct glenoid version. We used a similar technique in the current series, which may partially explain why outcomes were similar in the two studies. Bailie et al reported on 36 patients under 55 years of age that underwent cementless humeral resurfacing. Significant improvements in visual analog pain scores, Single Assessment Numeric Evaluation

| Table II | Comparison of self-assessed shoulder comfort and function following hemiarthroplasty with concentric glenoid reaming, and outcome after total shoulder arthroplasty performed by the same surgeon at the same institution |
|-----------------|---------------------------|-----------------------------|
| **Function** | Hemiarthroplasty and concentric glenoid reaming (n = 56) | Total shoulder arthroplasty* (n = 102) |
| Age | 22-55 (mean, 48 years old) | 25-89 (mean, 64 years old) |
| Length of follow-up | 2-7 years | 2.5-5 years |
| Preoperative function | 4.1 ± 2.5 | 4.2 ± 2.6 |
| Postoperative function | 9.5 ± 2.9 | 9.3 ± 3.1 |
| Change in function | +/-5.4 | +5.1 |
| Significance of change (P value) | <.001 | <.001 |
| Shoulders with better function following intervention | 53 (94%) | 96 (94%) |
| Shoulders with same function following intervention | 1 (2%) | 0 (0%) |
| Shoulders with worse function following intervention | 2 (4%) | 6 (6%) |

Significant improvement in shoulder function from preoperative status to most recent follow-up status

| Place arm comfortably at side | <.01 | <.01 |
| Sleep comfortably | <.01 | <.01 |
| Tuck in shirt | <.01 | <.01 |
| Place hand behind head | <.01 | <.01 |
| Place coin on a shelf | <.01 | <.01 |
| Lift 1 lb (0.5 kg) to shoulder level | <.01 | <.01 |
| Lift 8 lb (3.6 kg) to shoulder level | <.01 | <.01 |
| Carry 20 lb (9.1 kg) at side | <.01 | <.01 |
| Toss softball 20 yd (18.3 m) underhand | <.01 | NS |
| Toss softball 20 yd (18.3 m) overhand | <.01 | <.01 |
| Wash back of contralateral shoulder | <.01 | <.01 |
| Work full-time in regular job | <.01 | <.01 |

NS, not significant.
* Total shoulder arthroplasty results are from a study by Fehringer et al.
(SANE) scale, and American Shoulder and Elbow Surgeon (ASES) scores were observed. They treated eccentric glenoid wear with glenoid contouring, microfracture, or biologic resurfacing. Like these authors, we believe that obtaining a concentric glenoid is important for achieving improvement in comfort and function after nonprosthetic glenoid arthroplasty.

The preliminary results of humeral hemiarthroplasty and concentric glenoid reaming without interposition have previously been reported. Patients in this series demonstrated significant improvement in shoulder comfort and function following the procedure with an average increase of 4.7 (of a possible 12.0) functions on the SST. While the earlier report included patients of all ages, the present report focuses on patients 55 years old or less undergoing this procedure. For the group of 56 unrevised shoulders, the comfort and function was significantly improved. It is of interest that the results in these 56 patients are comparable to those previously reported by the same surgeon for total shoulder arthroplasty in all age groups. Of the 65 patients in which 2-year follow-up was available, revision surgery was carried out in 9. The revised shoulders tended to have more prior surgical procedures than those not having revision (3 ± 3 in comparison to 1 ± 1). Along with more prior surgeries, a low initial SST may influence the outcome: all of the 7 shoulders with inadequate follow-up, 7 of the 8 shoulders having revision surgery, and all of the 3 shoulders not improved had initial SST scores of 5 or less (Figure 1).

Our observations need to be interpreted in light of several important limitations. First, 7 of the 72 shoulders had inadequate follow-up, possibly hiding some additional failures. It is certainly possible that some of these patients experienced worse outcomes than those patients in the unrevised group and that these patients had revision surgery performed elsewhere. Second, there was no control group enabling side-by-side comparison of this to another method of treatment. Third, the results reflect those of an individual surgeon and may not be applicable to other practices. Fourth, some of the results were obtained in person and some by telephone. As we have previously reported, the mode of data collection can influence the results.

Despite these limitations, the data indicate that selected patients 55 years of age or younger undergoing humeral hemiarthroplasty combined with concentric reaming of the glenoid can experience significant improvements in self-assessed comfort and function. When radiographic follow-up was available, there was minimal glenoid erosion at a minimum follow-up of 2 years.

**Conclusion**

Patients under 55 years of age differ from older patients with respect to pathology, expectations, and the need for durability of the arthroplasty. Thoughtful surgeon-patient decision making is needed to select among the various surgical options. Humeral hemiarthroplasty with concentric glenoid reaming provides an opportunity for improvement in self-assessed comfort and function without the risks potentially associated with a polyethylene glenoid component or the complexities of soft tissue interposition. More clinical evidence on the criteria for patient selection and on the
quality and durability of the results obtained with the different methods will help inform future decision-making.

Disclaimer

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