

Nonprosthetic glenoid arthroplasty with humeral hemiarthroplasty and total shoulder arthroplasty yield similar self-assessed outcomes in the management of comparable patients with glenohumeral arthritis

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The risk of glenoid component failure has led us to explore nonprosthetic glenoid arthroplasty coupled with humeral hemiarthroplasty, the "ream and run" (R&R) procedure, for the management of glenohumeral arthritis in active patients. We hypothesized that patients having a R&R procedure would have outcomes comparable with those of similar patients having a total shoulder arthroplasty (TSA). A case-matched control study compared 35 consecutive patients (32 men, 3 women) with an average age of 56 years, after R&R with matched controls having TSA. The respective Simple Shoulder Test (SST) scores for the R&R and TSA groups were 4.5 and 4.0 before surgery, 7.8 and 9.6 at 12 months, 8.3 and 10.2 at 18 months, 8.9 and 9.4 at 24 months, 9.4 and 9.6 at 30 months, and 9.5 and 10.0 at 36 months. The "ream and run" procedure can offer similar functional recovery to patients with total shoulder arthroplasty, although the time to recovery may be longer. (J Shoulder Elbow Surg 2007;16:534-538.)

Total shoulder arthroplasty (TSA) offers patients with glenohumeral arthritis the potential for substantial relief of pain and increased shoulder function by resurfacing the arthritic joint, increasing stability through conformity of the prosthetic joint, and increasing strength and range of motion by lateralization of the

joint line.^{5,9,16,17,20,23} However, TSA has been associated with delayed failure of the glenoid component because of loosening, fragmentation, asymmetric wear, and instability.³⁶⁻³⁸ Surgical revision of these glenoid component failures often leads to substantially poorer function than primary arthroplasty.^{1,6,13,22,24,25,28-31}

In contrast with TSA, humeral hemiarthroplasty avoids the complications associated with the glenoid component. For this reason, and because of its relative technical simplicity, some surgeons prefer hemiarthroplasty for the treatment of glenohumeral arthritis. This appears to be particularly true for low-volume shoulder surgeons.¹² However, in a prospective randomized trial, hemiarthroplasty did not offer the same degree of pain relief as TSA.⁷ Patients who are treated with hemiarthroplasty, especially those who are young and active, may experience progression of their glenoid arthritis with associated medial erosion of the glenoid and loss of joint space. The resulting pain and stiffness may require revision of the hemiarthroplasty to a TSA.³² Poor outcomes from hemiarthroplasty appear to be more common in shoulders with asymmetric glenoid wear, especially when posterior erosion results in instability that cannot be addressed by hemiarthroplasty alone.^{11,14,33}

Because of the concern about late prosthetic glenoid failure in TSA and the sufficiency of hemiarthroplasty alone, we investigated a new procedure in which a humeral hemiarthroplasty is performed in conjunction with concentric reaming of the glenoid bone to spherical concavity with a diameter of curvature 2 mm greater than that of the prosthetic humeral head. In a human cadaver model, we have shown that nonprosthetic resurfacing of the glenoid can provide glenohumeral stability comparable with that provided by a polyethylene component.³⁵ In a living canine model, we have demonstrated that reaming of the glenoid bone and articulation with a humeral hemiarthroplasty heals and remodels to a concentric, smooth, fibrocartilage articular surface securely attached to the subjacent bone.¹⁸

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We hypothesized that human humeral hemiarthroplasty with nonprosthetic glenoid arthroplasty—the “ream and run” (R&R) procedure—would offer a recovery of self-assessed shoulder function similar to that after TSA, but because of the time required for healing and remodeling, the time for recovery of comfort and function would be longer than that for shoulders having conventional TSA.

MATERIALS AND METHODS

Patient selection

This was not a double-blinded, randomized clinical trial. We have a 30-year experience with TSA and offered this established procedure as a consideration to patients with severe glenohumeral arthritis. We offered the R&R procedure as an alternative to patients with severe glenohumeral arthritis who expressed interest in avoiding the risk of prosthetic glenoid failure but who also fully understood the potential for longer recovery time as well as for functional recovery was less than that expected for TSA. This option was not offered to patients with inflammatory arthritis. The patient made the final choice of procedure after a discussion of the options.

Surgical procedure

All R&R procedures were performed using a published technique; the approach and humeral preparation are similar to that used for TSA.¹⁹ The shoulder is approached through a deltopectoral incision. Adhesions in the humeroscapular motion interface are released. The subscapularis and subjacent capsule are incised from the lesser tuberosity. A 360° subscapularis release is performed. The humeral head is resected in 30° of retroversion at an angle of 45° with the long axis of the shaft. The humeral canal is prepared to receive the largest humeral stem that can be inserted without compromise of the endosteal surface of the diaphyseal cortex. Medullary impaction grafting is routinely done using autograft harvested from the resected humeral head until a snug fit of the prosthetic stem is achieved.

For the R&R procedure, the periglenoid capsular release is performed between the glenoid labrum and the capsule rather than between the labrum and bony glenoid as in TSA. Leaving the labrum attached to the glenoid enhances glenohumeral stability and load transfer. If preoperative and intraoperative assessment reveal posterior glenoid erosion and posterior humeral subluxation, the periglenoid release is restricted to the anterior capsule and the inferior glenohumeral ligament is left intact. Any residual cartilage or soft tissue is curetted from the glenoid surface. If the bony surface is biconcave as a result of posterior glenoid erosion, the bony ridge between the 2 concavities is removed using a pinecone burr.

The location for the hole for the glenoid reamer is selected so that the distance between the back, front, and top of the bony glenoid are approximately equal. The hole for the glenoid reamer is drilled in a direction so that reaming will normalize glenoid version without excessively compromising glenoid bone stock (glenoids with severe degrees of posterior wear may not be candidates for this procedure). The diameter of curvature of the glenoid reamer

is selected so that the reamed surface area of the glenoid bone will be maximized. In our experience, this is most commonly 54 mm, with 50 mm and 58 mm being the next most common diameters. Reaming continues until the reamed surface extends to the superior, anterior, and posterior aspects of the glenoid. Protruding inferior glenoid bone is resected to ensure it does not contact the medial humerus.

The humeral trial is inserted with a humeral head having a diameter of curvature 2 mm smaller than that of the glenoid concavity. The humeral trial is positioned so that the center of the humeral head sits exactly in the center of the reamed glenoid when the arm is abducted 30°. The thickness of the humeral head prosthesis is selected so that the arm can be externally rotated 40° with the subscapularis approximated, posteriorly subluxated no more than 50% on the posterior drawer test, and internally rotated no more than 60° when the arm is in 90° of abduction. Flexion of the arm should not result in more than 50% posterior subluxation. If greater degrees of posterior stability exist, a thicker humeral head is selected. Rotator interval closure may also be used to augment posterior stability.

Once the desired size and position of the humeral position of the humeral component have been determined, the definitive component (Global, DePuy, Warsaw, IN) is assembled and inserted into the impaction-grafted humeral canal. Again, the precise centering of the humeral head in the reamed glenoid is verified, with superior or inferior adjustments being made as necessary. Clearance between the medial humerus and lateral glenoid is verified.

The subscapularis is repaired to 6 sutures previously placed through the edge of the resected anterior humeral neck. Rotator interval closure is performed if necessary for additional posterior instability.

The postoperative protocol is identical to that used for TSA. After surgery, immediate continuous passive motion is instituted in the recovery room and for 36 hours after surgery. The patient conducts passive range-of-motion exercises 5 times a day. Activities of daily living, including lifting of objects up to 1 pound, are allowed as soon as they are comfortable. Nonsteroidal antiinflammatory medications are not used for at least 6 weeks after surgery. Formal strengthening exercises and more vigorous activities are not permitted until 3 months after surgery and until the shoulder has a comfortable passive range of motion, including elevation to 140°.

Data collection

At our center, all patients having any type of shoulder arthroplasty are entered prospectively into a shoulder outcomes database. The use of these data for research has been approved by our medical center’s Human Subjects Review Committee. From December 5, 2000, to April 1, 2005, 102 patients had received the R&R procedure. The study included 35 patients who had a minimum of 2 years follow-up; 2 patients were lost to follow-up.

An investigator blinded to the outcome of either procedure selected 35 comparable historical control patients from the database who had conventional TSA arthroplasty by the same surgeon. The TSA patients were selected by matching their diagnosis, gender, age, operative side, and

Table I Demographics of patients included in the study group

Characteristic	R&R	TSA
Mean age (years)	56	56
Gender		
Male	32	32
Female	3	3
Diagnosis		
Degenerative	26	26
Capsulorrhaphy	5	5
Secondary	4	4
Operative Side		
Right	19	13
Left	16	22
Average follow-up (years)	2.32	2.57
Initial SST score	4.49 ± 4.9	3.97 ± 4.5

R&R, "Ream and run" procedure; TSA, total shoulder arthroplasty; SST, Simple Shoulder Test.

length of follow-up. Preoperative and sequential postoperative shoulder comfort and function were documented by patient self-assessment using the Simple Shoulder Test (SST). This self-assessed outcome measure was selected because of its repeated demonstrated sensitivity to the functional limitations from glenohumeral arthritis and its responsiveness to treatment.^{2,5,15-17,21,26,27,34,39}

For both the R&R and TSA groups, the average age of patients was 56 years, and 32 of 35 patients were men. Degenerative arthritis was present in 26, capsulorrhaphy arthropathy in 5, and secondary arthritis in 4. Average time of follow-up was 2.6 years for R&R patients and 2.7 for those having TSA (Table I).

The initial SST scores for the R&R shoulders was 4.49 ± 4.9 of 12 functions, whereas the initial SST scores for the TSA shoulders was 3.97 ± 4.52 ($P = .36$). Follow-up SST scores were compared for each 6-month interval after surgery.

The follow-up SST (FSST) scores for each group at each time interval were compared using the unpaired t test assuming unequal variance.

RESULTS

Both the TSA and R&R patients showed substantial and comparable improvement after surgery. Initial SST (ISST) scores were found to be similar between R&R patients and controls, with a mean ISST of 4.5 for R&R vs 4.0 for TSA ($P = .36$). Mean final SST scores (FSST) were 8.12 for TSA vs 6.67 for R&R run ($P = .23$). Using batched data for 6-month intervals, we found that at 12 months postoperatively, the patients receiving TSA showed improved FSST scores, with a mean score of 9.6 vs 7.8 for R&R ($P = .01$). By 18 months, however, differences were not statistically significant, with SST scores of 8.9 for R&R vs 9.4 for TSA ($P = .47$). This trend continued for the remainder of the study period, with no significant differences at 24 months, 9.4 vs 9.6 at 30 months ($P = .82$), and 9.5 vs 10.0 at 36 months ($P = .63$) for R&R vs TSA,

respectively. The follow-up SST scores are summarized in Table II and Figure 1.

DISCUSSION

The R&R procedure differs from TSA in that neither a glenoid component nor methyl methacrylate (both potential sources of prosthetic failure) is used. The R&R procedure differs from a humeral hemiarthroplasty in that the glenoid bone is reamed to a diameter of curvature 2 mm greater than that of the humeral head prosthesis. This reaming has 2 potential advantages: (1) in our animal study,¹⁸ reaming was followed by healing with complete coverage of the glenoid surface with remodeling fibrocartilage adherent to the underlying bone, and (2) incongruities of the glenoid surface were resolved. These 2 features may help mitigate the progressive erosion that has been reported with hemiarthroplasty alone.¹⁰ Longer-term radiographic follow-up will be required to determine if any of these shoulders shows glenoid erosion.

The relatively young age (56 years) and strong male predominance (32 of 35) in the study cohort and in the matched controls indicates that this procedure is selected by a group of patients that is somewhat different than the conventional TSA population, which tends to be older and more even in gender distribution.

In this blinded case-matched study, the functional results of humeral hemiarthroplasty with nonprosthetic glenoid resurfacing and the results of conventional TSA were comparable, although it appeared to take an average of 12 to 18 months longer for the R&R shoulders to achieve similar shoulder function as patients receiving TSA. This delay may reflect the time required for the healing and remodeling of the reamed glenoid bone, processes that are not required when a polyethylene glenoid prosthesis is used. This suggests that patients receiving an R&R may have a more prolonged functional recovery; however, it does not come with the risk of a glenoid component and in the end is equivalent to TSA at 2 to 3 years of follow-up.

This study should be interpreted in light of certain limitations:

- Although we matched the R&R patients with comparable TSA patients while blinded to the end results of either procedure, this was not a prospective, randomized clinical trial. Blinded case-matching provides for a control group that is similar to the test group.⁸ In this study, the matching procedure yielded 2 groups of patients with very similar preoperative characteristics, including their level of shoulder function.
- Not all patients having TSA and the R&R procedures provided data at each of the desired times of follow-up.

Table II Self-assessed shoulder function at 6-month intervals after “ream and run” and total shoulder arthroplasty

	6 months	12 months	18 months	24 months	30 months	36 months
R&R						
Mean	6.67	7.77	8.36	8.89	9.42	9.45
SD	3.11	3.12	3.17	2.19	2.19	3.3
SEM	0.8	0.66	0.96	0.52	0.45	0.99
N	15	22	11	18	24	11
95% CI	4.94-8.39	6.39-9.15	6.23-10.49	7.80-9.98	8.49-10.34	7.24-11.67
TSA						
Mean	8.12	9.64	10.23	9.41	9.58	9.96
SD	3.57	1.63	2.54	2.32	2.8	2.84
SEM	0.87	0.33	0.46	0.5	0.55	0.56
N	17	25	31	22	26	26
95% CI	6.28-9.95	8.97-10.31	9.29-11.16	8.38-10.44	8.44-10.71	8.82-11.11
P	NS	<.01	NS	NS	NS	NS

R&R, “Ream and run procedure”; TSA, total shoulder arthroplasty; SD, standard deviation; SEM, standard error of the mean; CI, confidence interval; NS, not significant.

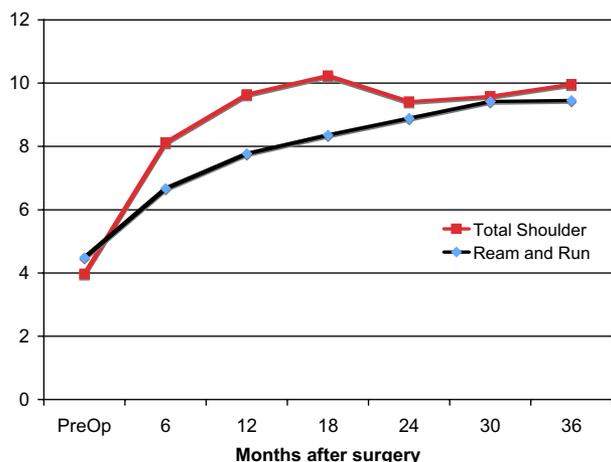


Figure 1 Self-assessed shoulder function before and sequentially after a “ream and run” procedure (diamonds) and total shoulder arthroplasty (squares).

- This is a relatively small series of patients with limited follow-up, so that the ultimate fate of either or both of the procedures may not be revealed by the available data.
- All of these data were from the practice of an individual surgeon and, therefore, may not be generalizable.
- Our follow-up was not sufficiently long to encompass the time when glenoid components fail (5 or more years after TSA), thus the potential long-term benefits of the R&R procedure are not revealed by this study.
- The cohort of patients was evaluated using the previously validated SST to assess patients’ self-described functional outcome. We did not evaluate for pain and range of motion in either

group, although this is indirectly achieved through the SST.

CONCLUSION

Despite these limitations, our results demonstrate that the 2-year to 3-year functional improvement after the “ream and run” procedure is similar to that after total shoulder arthroplasty when the 2 procedures are performed in comparable patients.

We are encouraged that the “ream and run” procedure may be a consideration for young and active patients willing to invest a longer recovery time in return for freedom from the risk of prosthetic glenoid component failure. However, further study is needed to draw long-term conclusions on the efficacy and durability of the “ream and run” procedure compared with the traditional total shoulder arthroplasty.

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