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Clinical outcomes of reverse total shoulder arthroplasty in patients aged younger than 60 years

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Background: Reverse total shoulder arthroplasty (RTSA) has been indicated primarily for patients aged older than 65 years with symptomatic rotator cuff deficiency, poor function, and pain. However, conditions that benefit from RTSA are not restricted to an elderly population. This study evaluates a consecutive series of RTSA patients aged younger than 60 years.

Methods: We evaluated 36 shoulders (mean age, 54 years) at a mean follow-up of 2.8 years (range, 24-48 months). Of these shoulders, 30 (83%) had previous surgery, averaging 2.5 procedures per patient. The preoperative conditions compelling RTSA were as follows: failed rotator cuff repair (12), fracture sequelae (11), failed arthroplasty (5), instability sequelae (4), cuff tear arthropathy (CTA) (4), and rheumatoid arthritis (2). Follow-up examinations included range-of-motion and strength testing, as well as Single Assessment Numeric Evaluation, visual analog scale, Simple Shoulder Test, American Shoulder and Elbow Surgeons (ASES), and Constant scores. Preoperative and postoperative radiographs were reviewed for component loosening and scapular notching. Failure criteria were defined as undergoing revision, having gross loosening, or having an ASES score below 50.

Results: The mean Single Assessment Numeric Evaluation score improved from 24.4 to 72.0; the visual analog scale pain score improved from 6 to 2.1. The Simple Shoulder Test score improved from 1.4 to 6.2, and the ASES score improved from 31.4 to 65.8. Active forward elevation improved from 56° to 121°. The normalized postoperative mean Constant score was 54.3. In 9 patients (25.0%), we recorded an ASES score below 50, and these cases were considered failures.

Conclusion: RTSA can improve shoulder function in a younger, complex patient population with poor preoperative functional ability. This study's success rate was 75% at 2.8 years. This is a limited-goals procedure, and longer-term studies are required to determine whether similar results are maintained over time.

Level of evidence: Level IV, Case Series, Treatment Study.

Keywords: Reverse total shoulder arthroplasty; RTSA; shoulder; 2-year follow-up; outcomes; under 60 years

Reverse total shoulder arthroplasty (RTSA) has been established as an effective treatment for patients with rotator cuff deficiency, pain, and poor function; typically, cuff tear arthropathy has been the primary diagnosis. However, other shoulder conditions with a dysfunctional or irreparable

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rotator cuff and joint injury have been treated with RTSA.[2,10,13,18,21,23] Outcomes have been shown to be correlated with the preoperative diagnosis and the indication for surgery. Wall et al[23] showed that primary arthropathies result in better outcomes than post-traumatic etiologies or revision cases. Furthermore, Frankel and colleagues[25] described the use of RTSA in proximal humeral malunions, Cazeneuve and Cristofari[4] reported on outcomes for fracture treatment, and Holcomb et al[12] described successful use in the rheumatoid population. The reverse shoulder replacement has become a valuable tool for the shoulder surgeon and can be applied to a variety of pathologies.

Traditionally, the majority of RTSAs are performed in an older patient population with low functional demands on their shoulders.[10,21] However, the conditions that potentially benefit from an RTSA are not restricted to an elderly population. We consider the use of RTSA in patients with symptomatic irreparable rotator cuff deficiency, poor active elevation ($<60°$), pain, or joint injury (degenerative joint disease [DJD], existing implant, or fracture). Few studies in the literature specifically analyze the clinical outcome of RTSA in a younger (<60 years) population. We hypothesize that younger patients will have improvements in function and pain profiles similar to those seen in an older patient population. The purpose of this study is to report the clinical outcomes (range of motion [ROM], strength, patient function) of patients aged younger than 60 years who underwent a primary RTSA. The preoperative clinical conditions that compelled consideration of an RTSA were evaluated, as were the preoperative diagnoses.

Methods

The records of all patients who had undergone RTSA between February 2007 and September 2009 were retrospectively reviewed. We identified 41 consecutive patients (42 shoulders) who met the study criteria. Six were lost to follow-up. The inclusion criteria were as follows: reverse shoulder arthroplasty and age younger than 60 years at the time of the RTSA surgery. Four fellowship-trained orthopaedic surgeons (G.P.N., A.A.R., N.N.V., and B.J.C.) performed all the surgeries in 1 high-volume clinical practice.

There were 36 shoulders available for follow-up (Table I), with a mean age of 54.4 years (range, 39-59.9 years). The mean follow-up was 2.8 years (range, 2-4.0 years). There were 24 female and 12 male shoulders. Of the 36 shoulders, 30 (83%) had previous surgery, with a mean number of procedures of 2.5 per shoulder (range, 1-7). The preoperative diagnostic conditions were as follows: failed rotator cuff repair (RCR) (12), fracture sequelae (open reduction internal fixation (ORIF), hemiarthroplasty, malunion) (9), failed arthroplasty (5), instability sequelae (locked dislocation with rotator cuff tear and post-dislocation DJD with rotator cuff tear) (4), CTA (4), and rheumatoid arthritis (2).

All procedures were performed through a standard deltopectoral approach. Reverse shoulder arthroplasty used a cemented or uncemented humeral component with a cemented glenoid implant. Patients were kept in a shoulder sling for 1 month with only passive ROM exercises allowed. They were allowed to use the arm in the sling for activities of daily living, but formal physical therapy for the shoulder was not performed. At 1 month, the sling was discontinued and closed-chain deltoid and teres minor exercises at home were initiated.

Patients meeting the study criteria were contacted to participate in the study. Operative reports and clinic notes were reviewed to identify factors of interest including previous procedures, mechanism of injury, diagnosis at the time of surgery, and concomitant procedures. Patients with Hamada criteria grade 1, 2, or 3 were considered to have an irreparable rotator cuff tear without arthritis. Patients with Hamada criteria grade 4 or 5 were considered to have cuff tear arthropathy. Patients were classified as having post-traumatic glenohumeral arthritis if they had glenohumeral arthritis and a history of a proximal humeral fracture.

Preoperative ROM of the problem shoulder, demographic information (age, sex, hand dominance, side of shoulder surgery), occupation, history of diabetes, and tobacco use were recorded. At follow-up, a shoulder examination was performed by a trained, independent observer assessing active and passive ROM and strength. ROM was assessed with a goniometer. Strength of forward flexion and external rotation was quantified with a manual muscle dynamometer (PowerTrackII; JTech Medical, Salt Lake City, UT, USA). Forward flexion strength was measured with the arm in the scapular plane while the patient was standing; external rotation strength was measured with the arm at the side and the elbow in 90° of flexion. The maximum value from 3 trials was used. This value was then divided by the power obtained from the other ''healthy'' arm to obtain a normalized value. The maximum normalized value allowed was 1.

Each patient was also given a postoperative questionnaire including 4 standardized assessment tools: Single Assessment Numeric Evaluation (SANE) score, pain score on a visual analog scale (VAS), Simple Shoulder Test (SST) score, and American Shoulder and Elbow Surgeons (ASES) score. A normalized Constant-Murley score was computed by calculating each patient's score by use of age- and sex-matched normal Constant-Murley scores reported in the literature.[14]

Preoperative and postoperative anteroposterior and axillary shoulder radiographs were reviewed by 2 independent observers. Preoperative radiographs were evaluated for rotator cuff dysfunction according to criteria described by Hamada et al.[11] Criteria described by Rispoli et al[19] were used to assess glenoid cartilage loss and glenohumeral subluxation.

The most recent postoperative radiographs were assessed for evidence of humeral component loosening, glenoid component loosening, scapular notching, osteoarthritis, fracture, and dislocation. Humeral component loosening was based on criteria described by Sperling et al,[22] where a humeral component was deemed ''at risk'' for loosening if a lucent line greater than 2 mm in width was present in at least 3 of 8 zones or if 2 of 3 independent observers identified migration or tilt of the component. Glenoid component loosening was based on the 6-part grading scale described by Lazarus et al.[15] Scapular notching is a defect of the bone in the inferior region of the glenoid component. It was assessed based on the 4-part grading scale described by Sirveaux et al.[21]

Preoperative and postoperative ROM and scores were compared with paired tests for all patients. $P < .05$ was considered statistically significant. Clinical failure criteria were defined as a revision, gross loosening of a component, or an ASES score below 50.

Table I Patient demographic characteristics

	Data (n = 36)
Age (y)	54.4 ± 3.8
Male	33.3%
Dominant arm injury	59%
Job injury	21%
Diabetes	19%
Tobacco history	50%
Legal claim	6%

Results

Table I shows demographic information for the cohort. At the time of surgery, 22 patients had been working; at the time of follow-up, 12 (54.5%) of these patients were currently working, although 1 had switched to a desk job.

Table II summarizes the preoperative and postoperative data. Postoperative SANE, VAS, ASES, and SST scores and forward flexion were all significantly improved from preoperative values ($P < .05$). The mean active elevation improved from 56° to 121°, and 82% of patients were able to actively elevate above 90°. The ASES score significantly improved from a preoperative mean of 31.4 to a postoperative mean of 65.8. There were, however, 9 patients with ASES scores below 50, and these cases were classified as clinical failures.

Preoperative and postoperative radiographic findings are shown in Tables III, IV, and V. Radiographic follow-up imaging was available for 33 patients (91.6%), averaging 2.8 ± 1.0 years (range, 0.5-4.5 years). We classified 1 patient (3.0%) as at risk for humeral component loosening, and this patient had an ASES score of 23. No patients were found to have radiographic signs of glenoid component loosening. No radiographic lucencies were present in 24 patients (72.7%), whereas 9 patients (27.3%) had grade 1 radiolucency. No patients were found to have grade 2 radiolucency or higher. Evidence of grade 1 scapular notching was present in 6 patients (18.2%). There was no correlation between preoperative or postoperative radiographic findings and clinical outcomes.

Six patients had major complications, as summarized in Table VI. Three patients had revisions at 2 months, 6 months, and 2.8 years postoperatively. Patient 1 had a significant history of multiple shoulder surgeries, including 4 nonunions of a humeral fracture that required a large proximal humeral allograft affixed with a locking intramedullary nail. The patient lacked attachments from the rotator cuff to the proximal humerus and had severe anterosuperior instability. The surgery was a 2-part procedure: (1) the intramedullary nail was removed before surgery and the wound was allowed to heal, and (2) the patient was re-evaluated and underwent a long-stem RTSA. Postoperatively, the patient was placed in an abduction pillow for 4 to 6 weeks. However, while in the hospital, the patient required a chest radiograph, and his arm was removed from the abduction pillow and extended. The shoulder was then found to be dislocated at his 2-week follow-up visit. After repeated dislocations, it became apparent that the shoulder would not remain stable, and the patient underwent revision to a large-head hemiarthroplasty.

Table II Comparison of preoperative and postoperative shoulder function among 36 patients

	Preoperative	Postoperative
SANE score	24.4 ± 14.3	72.0 ± 20.9
VAS score	6.0 ± 3.1	2.1 ± 2.0
ASES score	31.4 ± 18.4	65.8 ± 20.6
SST score	1.4 ± 1.6	6.2 ± 3.7
Constant score	—	54.3 ± 18.9
FE (°)	57 ± 28	121 ± 46
FE > 90°	19%	82%
ER (°)	23 ± 19	30 ± 17
FE strength (%)	—	75.0 ± 25.5
ER strength (%)	—	70.0 ± 31.4

ER, External rotation; *FE*, forward elevation.
$P < .05$ for all comparisons.

Table III Findings on preoperative radiographs

Measure	n (%)
Hamada	
Grade 1	3 (11.1)
Grade 2	14 (51.9)
Grade 3	4 (14.8)
Grade 4	6 (22.2)
Glenoid erosion	
None	0 (0)
Mild	9 (33.3)
Moderate	12 (44.5)
Severe	6 (22.2)
Glenoid subluxation	
None	0 (0)
Mild	4 (14.8)
Moderate	8 (29.6)
Severe	15 (55.6)

Patient 2 had a history of progressive shoulder pain with rotator cuff deficiency, as well as adaptive changes on the humeral head. Postoperatively, the patient was immobilized appropriately and underwent home therapy. At 3 months postoperatively, the patient began having subluxation with horizontal extension or abduction–external rotation. Subluxation was unable to be reproduced on fluoroscopy. The patient was placed in an abduction pillow, but subluxation continued. It was believed that the myofascial sleeve had been stretched and a revision to a larger glenosphere for extra stability was necessary. This patient has subsequently remained stable with no pain and active elevation of greater than 130°.

Patient 3 had a history of failed hemiarthroplasty for fracture fixation. The patient did well after RTSA until

Table IV Grading scale for radiolucencies about keeled glenoid components

	Description	n (%)
Grade 0	No radiolucency	24 (72.7)
Grade 1	Radiolucency at superior or inferior fringe	9 (27.3)
Grade 2	Incomplete radiolucency	0 (0)
Grade 3	Complete radiolucency <2 mm around keel	0 (0)
Grade 4	Complete radiolucency >2 mm around keel	0 (0)
Grade 5	Gross loosening	0 (0)

Grades 0 and 1 are defined as "better cementing" and grades 2 and 3 as "worse cementing" on early postoperative follow-up.

Table V Scapular notching grades for patients after (reverse) total shoulder arthroplasty

	Description	n (%)
Grade 0	No defect	27 (90)
Grade 1	Defect confined to pillar	6 (18.2)
Grade 2	Defect in contact with lower screw	0 (0)
Grade 3	Defect over lower screw	0 (0)
Grade 4	Defect extends under baseplate	0 (0)

Table VI Complications, time from surgery, and treatments

Complication	Time from surgery	Treatment
Recurrent dislocations	2 mo	Revision to large-head hemiarthroplasty
Recurrent subluxation	6 mo	Revision to larger glenosphere
Traumatic dislocation	2.8 y	Revision with resection arthroplasty
Traumatic dislocation	1 wk	Open reduction
Periprosthetic fracture	Intraoperatively	Long-stem RTSA, cerclage wires
Acromion fracture (fall)	4 mo	Nonoperative

a traumatic dislocation at 2.8 years postoperatively. The patient did not seek medical attention until 4 months after the dislocation of the RTSA. The shoulder was chronically dislocated and required removal of components to a modular oncologic bipolar hemiarthroplasty. Nine weeks after revision hemiarthroplasty, the shoulder dislocated again. Proximal modular components were removed, and a resection arthroplasty was performed.

Discussion

RTSA has shown clinical efficacy in the setting of a degenerative or dysfunctional rotator cuff–deficient shoulder. Specifically, RTSA has been shown to reliably resolve pain and restore function in patients with rotator cuff arthropathy,[1,10,18,21] and encouraging results have been shown at up to 2 years in patients with rheumatoid arthritis.[12,18] Furthermore, a variety of studies have analyzed and shown good outcomes of RTSA for severe bone loss, multi-part fractures in the elderly, failed fracture fixation, and revision shoulder arthroplasty.[3,21,23,24] However, to our knowledge, all previous literature either has focused on an elderly patient population or has not segmented results based on patient age. As surgeons are more frequently faced with younger patients who could benefit from RTSA and as the indications for RTSA continue to expand, the patient population treated continues to expand. This study reports on the clinical and radiographic results at midterm follow-up (mean, 2.8 years) in young patients (aged <60 years) with an RTSA.

To our knowledge, there have been few reports that directly deal with reverse arthroplasty in a younger patient population, specifically those younger 60 years. A recent retrospective study of 41 patients aged younger than 65 years by Ek et al[8] found that RTSA in younger patients provides subjective improvement of overall shoulder function maintained up to 10 years after treatment. In comparison to our study, they reported a similar postoperative mean Constant score (57 vs 54.3) but with higher complication rates (37.5% vs 13.9%) and lower overall implant survivorship (75% vs 91%). Likewise, a recent multicenter retrospective cohort study by Dillon et al[7] focused on shoulder arthroplasty in 504 patients aged 59 years or younger versus 2,477 patients aged 60 years or older, with a mean follow-up of 2.2 years. They reported a 2 times higher risk of revision arthroplasty in patients aged 59 years or younger at early follow-up when compared with an older population. Furthermore, the study suggests that its findings support those of Guery et al,[10] who recommend avoiding RTSA in patients aged younger than 70 years when possible. However, only 6 patients aged 59 years or younger received RTSA, with the remainder undergoing primarily hemiarthroplasty and total shoulder arthroplasty (TSA).

Concerning information can be extrapolated from the study by Favard et al[9] that may have applicability for a young patient. In this report, 489 patients with a reverse prosthesis were reviewed with 2, 5, 7, and 9 years' follow-up. Under the care of world-renowned shoulder surgeons, the complication rate was 18%, with a 10-year survival rate of 89%. The authors also showed a relative decline in function with longer follow-up. The Constant-Murley score in patients with more than 9 years' follow-up was significantly lower than that in those with fewer than 5 years' follow-up. Humeral, glenoid, and scapular notching was also present in 39%, 32%, and 50%, respectively, of patients with more than 9 years' follow-up. The authors conclude that these results are concerning for the longevity of the reverse prosthesis and it should be used with caution in a younger patient population.

Zumstein et al[26] further illustrated these potential issues in a systematic review that found rates for problems, complications, reoperations, and revisions after RTSA of 44%, 24%, 3.5%, and 10%, respectively.

De Wilde et al[5,6] have looked at the results of reverse arthroplasty in younger patient populations with specific etiologies: tumor resection and failure of previous arthroplasty. They reported promising results, but the sample size was low (4 patients and 5 patients). Rittmeister and Kerschbaumer[20] studied 4 younger patients in a sample of 8 patients with advanced rheumatoid arthritis. One of these patients had failure and removal of the prosthesis whereas the other 3 went on to have good results at a mean of 54 months. However, the patient populations in these studies were small and are not representative of a general reverse patient population.

As expected, our patients had fewer arthritic changes than are typically seen in an older population. Seventy-eight percent of patients had Hamada grade 1, 2, or 3, which is higher than reported in other studies.[2,23] The postoperative complication rate in this study (13.9%) is similar to previously reported rates.[17,23] We also obtained similar survival results, with an overall implant survival rate of 91%. However, when an ASES score below 50 is considered an endpoint, the survival rate decreases to 75%.

Furthermore, the normalized postoperative Constant score (mean, 54.3) reported in our study was similar to that in studies by Wall et al[23] (mean, 59.7), Ek et al[8] (mean, 57), and Boileau et al[1] (mean, 55.8). Likewise, the postoperative ASES score of 65.8 is within the range of scores reported in other studies.[2,16,17] Our results for the 11 patients classified as having irreparable rotator cuff tears without glenohumeral arthritis (VAS score, 1.7; ASES score, 71.8; SST score, 7.4) correspond well with the results of older patients (mean age, 71 years) with the same etiology on whom Mulieri et al[17] reported (VAS score, 1.9; ASES score, 75.4; SST score, 6.5). Furthermore, our results for the 9 patients treated for failed arthroplasty (VAS score, 1.8; ASES score, 66.4; SST score, 5.5) compare favorably with the results of older patients (mean age, 69 years) with the same etiology in a study by Levy et al[16] (VAS score, 2.44; ASES score, 52.1; SST score, 2.6).

Wall et al[23] reported that patients with revision arthroplasty and post-traumatic glenohumeral arthritis had significantly worse postoperative outcomes in comparison to cuff arthropathy and massive rotator cuff tear patients. We did not find that postoperative scores differed significantly statistically between groups. However, 7 of 19 patients (37%) with a revision arthroplasty, post-traumatic glenohumeral arthritis, or humeral malunion from failed fracture fixation were considered clinical failures, as compared with 3 of 14 patients (21%) with CTA or irreparable rotator cuff tears.

In our patients, the improvement in active forward flexion (from 56° to 121°) was similar to or greater than the improvement in the studies by Wall et al[23] (from 86° to 137°), Boileau et al[2] (from 82° to 123°), Mulieri et al[17] (from 53° to 134°), and Levy et al[16] (from 38° to 72°). Postoperatively, the shoulder with the prosthesis had 70% to 75% of the strength in forward elevation and external rotation of the "healthy" arm. More than 75% of patients regained strength in forward elevation and external rotation to at least 50% of their uninjured arm.

Our low postoperative rates of gross glenoid or humeral loosening (3.0%) are similar to rates in other studies.[2,8,16,17,23] The incidence of scapular notching (18.2%) is much lower than rates reported by Boileau et al[2] (74%), Ek et al[8] at 2 to 5 years (46%), and Wall et al[23] (50.7%) but is similar to the rate in the study by Mulieri et al[17] only looking at patients with preoperative Hamada grade 1, 2, or 3 (13%).

This study has some limitations. The retrospective design prevents a direct comparison between RTSA and other treatments for the included etiologies. All the procedures were performed by 4 experienced shoulder surgeons at 1 institution; less experienced surgeons may not obtain the same outcomes. In addition, the minimum follow-up duration of 18 months is relatively short for a reverse total shoulder replacement, and much longer follow-up is required for these young patients.

To our knowledge, this study is the first reported series of clinical outcomes of RTSA in younger patients. This is a patient population that is growing in both size and importance as the indications for reverse arthroplasty continue to expand. This patient population aged younger than 60 years was complex, with very poor function, previous surgery, fractures, and/or instability sequelae. In addition, this population had clinical conditions that combined rotator cuff deficiency, poor active elevation, joint damage, and pain that led to severe shoulder dysfunction. Anterosuperior instability or escape was also present in this group. Functional compromise was significant, and patients desired to use their hand away from their body from waist to chest level for simple activities of daily living. Thus, there are very few options to provide this functional ability besides RTSA, especially in a complex population in which 83% of patients had previous shoulder surgery.

These patients can be expected to have higher functional levels and require longer implant survival when compared with the more traditional elderly patient. In this study, patients aged younger than 60 years had significant functional increases and decreases in pain compared with preoperative scores at a mean follow-up of 2.8 years. However, of notable concern is that clinical results have been shown to deteriorate after 6 to 8 years. Thus, although our midterm results show good survivorship (91%), an acceptable complication rate (13.9%), and improved functional scores, longer-term follow-up is certainly necessary in this younger patient population.[10]

Conclusion

The results of this study indicate that RTSA in patients aged younger than 60 years provides pain relief and restores shoulder function as indicated by improved active forward elevation and SST, ASES, and Constant scores at a mean of 2.8 years. However, given the short duration of follow-up and the reported rates of clinical failure after more than 5 years of follow-up,[8,11] reverse shoulder arthroplasty should still be used judiciously. Longer-term studies are required to determine whether similar results are maintained over time.

Disclaimer

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