Preoperative partial-thickness rotator cuff tears do not compromise anatomic total shoulder replacement outcomes: medium-term follow-up

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Background: Reverse total shoulder replacement (TSR) in elderly patients with primary osteoarthritis (OA) and rotator cuff pathology is increasingly being performed. The purpose of our study was to determine the medium-term results of anatomic TSR for OA in patients with established preoperative partial-thickness rotator cuff tears on magnetic resonance imaging (MRI) scans.

Methods: We reviewed a cohort of patients who had undergone anatomic TSR for OA with a preoperative MRI diagnosis of partial-thickness rotator cuff tear. Patients were assessed with preoperative and post operative Oxford Shoulder Scores, evaluation of their range-of-movement and clinical rotator cuff assessment. Anteroposterior and axillary radiographs were used to assess for any proximal humeral migration (using the Torchia classification) and any evidence of loosening. The Lazarus score was used to grade glenoid radiolucencies.

Results: The study comprised 36 patients (14 men and 22 women) who underwent TSR and had partial-thickness rotator cuff tears on MRI; preoperatively, all showed mild to moderate fatty infiltration. The mean age of the patients was 79.2 years (range, 75-88 years); the mean follow-up period was 5.8 years (range, 5-9 years). Significant improvements in pain and range of movement were reported in all cases. At the final follow-up, the mean Oxford Shoulder Score was 42 points (range, 32-46 points), with a minimum improvement of 14 points ($P = .001$). External rotation (20° vs. 40°, $P = .001$), forward flexion (80° vs. 140°, $P = .015$), abduction (45° vs. 90°, $P = .015$), and internal rotation also improved. Lucencies were observed in 8 glenoids, with 6 showing grade 1 Lazarus changes, 2 showing grade 2, and none showing grade 3. There were no cases of implant loosening. Clinically, 4 patients had rotator cuff weakness but only 2 showed evidence of proximal migration. One patient remained satisfied, whereas the other patient, with moderate-grade proximal migration according to the Torchia classification, underwent revision for rotator cuff failure; one further patient underwent washout and DAIR (débridement, antibiotics, and implant retention) for infection.

Discussion: There is a paucity of literature on whether a preoperative partial-thickness rotator cuff tear has an adverse effect on the outcome of TSR. Our results show that the presence of a partial cuff tear on preoperative MRI does not significantly affect function after anatomic TSR in the medium term. With anatomic TSR having less morbidity for patients and allowing greater potential options for revision, we believe that the use of reverse shoulder arthroplasty in this cohort of patients, with partial rotator cuff tears, may not be necessary and we advocate consideration of anatomic TSR in this patient group.

Institutional review board approval was not required for this study.

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In England, Wales, and Northern Ireland, there has been a 5-fold increase in the numbers of shoulder arthroplasties performed from 2012 to 2017.[14] The decision to perform anatomic total shoulder replacement in a patient is dependent on the integrity of the rotator cuff. Patients who have rotator cuff tears may experience poorer outcomes owing to proximal migration of the humeral head and glenoid component loosening.[4]

Reverse shoulder arthroplasty, traditionally performed for cuff arthropathy because of its biomechanical advantage, is increasingly being performed as a first-line procedure in older patients with primary glenohumeral osteoarthritis who also have a degenerative or partial cuff tear instead of performing an anatomic total shoulder replacement.[18]

There is a paucity of evidence on the effect of established partial cuff tears and their influence on anatomic total shoulder replacement outcomes. The aim of this study was to explore the medium- to long-term outcomes in patients undergoing anatomic total shoulder replacement with established partial rotator cuff tears, as well as answer the question of whether performing anatomic total shoulder replacement in this group of patients, despite partial rotator cuff tears, remains a viable option.

Materials and methods

We conducted a cohort study using existing data from an electronic patient record database from a single institution between October 2009 and December 2014. The eligibility criteria included all adults aged ≥ 75 years who underwent an anatomic total shoulder replacement for glenohumeral osteoarthritis (post-trauma patients were excluded) with a confirmed partial-thickness rotator cuff tear on preoperative magnetic resonance imaging (MRI) and with a minimum of 5 years' follow-up. A partial-thickness rotator cuff tear was defined on an MRI scan as a demonstrable amount of rotator cuff thickness remaining intact (therefore not full thickness) and classified based on the percentage tear of the rotator cuff tendon: grade 1, <25% (<3 mm); grade 2, 25%-50% (3-6 mm); or grade 3, >50% (>6 mm). Our MRI scans were reported and graded by a fellowship-trained senior consultant musculoskeletal radiologist and confirmed by a fellowship-trained senior consultant specialist shoulder and elbow surgeon.

Case note review was used to retrieve outcome data for each patient and to supplement data obtained from the electronic patient records to minimize missing data. Variables collected included patient demographic characteristics (age, sex), preoperative MRI partial-thickness rotator cuff tear grading, MRI grading of rotator cuff fatty infiltration according to the modified Goutallier

classification,[7] preoperative and postoperative (including 5-year follow-up) radiographs, preoperative Oxford Shoulder Score (OSS) and postoperative (1- and 5-year) OSS, preoperative and postoperative (1- and 5-year) range of movement (ROM), clinical rotator cuff assessments (at 1 year and 5 years), and any reoperation within 5 years of surgery for infection or revision.

The primary outcome measures were postoperative OSS, clinical appearance on postoperative radiographs at 5 years, and serial clinical examination for cuff tears. Postoperative radiographs were assessed for proximal migration of the humeral component using the Torchia classification,[22] as summarized in Table I, and for glenoid loosening using the Lazarus score.[10] Secondary outcome measures included ROM and any reoperations.
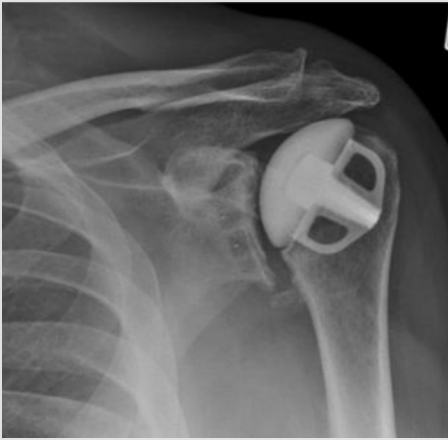
Statistical analysis

The sample size was based on the number of patients with a minimum of 5 years' follow-up. Continuous variables were reported as means with ranges, and categorical variables were reported as frequencies with percentages. $P < .05$ was considered statistically significant for all analyses. The Student t test was used to compare the preoperative and postoperative (5-year) outcome scores. Statistical analysis was performed using SPSS software (IBM, Armonk, NY, USA).

Results

A total of 36 patients (14 men and 22 women) met the inclusion criteria, and there were no missing data. All patients were followed up successfully, with no patients lost to follow-up. All patients had partial-thickness cuff tears and mild to moderate fatty infiltration of the rotator cuff on preoperative MRI (Fig. 1). There were 6 patients with grade 1 partial-thickness cuff tears, 28 with grade 2 tears, and 2 with grade 3 tears. The breakdown of the Goutallier classification was grade 2 in 16 patients, grade 3 in 14, and grade 4 in 6.

Women comprised 61% of the patients (n = 22), and the mean age of the patient population was 79.2 years (range, 75-88 years). The average follow-up period was 5.8 years (range, 5-9 years). All patients reported improvements in pain and ROM following surgery. The OSS significantly improved postoperatively; the mean preoperative OSS was 14.7 points (range, 9-19 points), and at the final follow-up, the mean OSS was 42 points (range, 32-46 points), with a minimum improvement of 14 points ($P = .001$, paired t test). Significant improvements in range of motion were also observed, especially external rotation, forward flexion, and abduction (Table II).

Table I Summary of Torchia classification[22]

	Proximal translation	Radiographic appearance
Mild	<25% of diameter of prosthetic head	
Moderate	Between 25% and 50% of diameter of prosthetic head	
Severe	>50% of diameter of prosthetic humeral head	
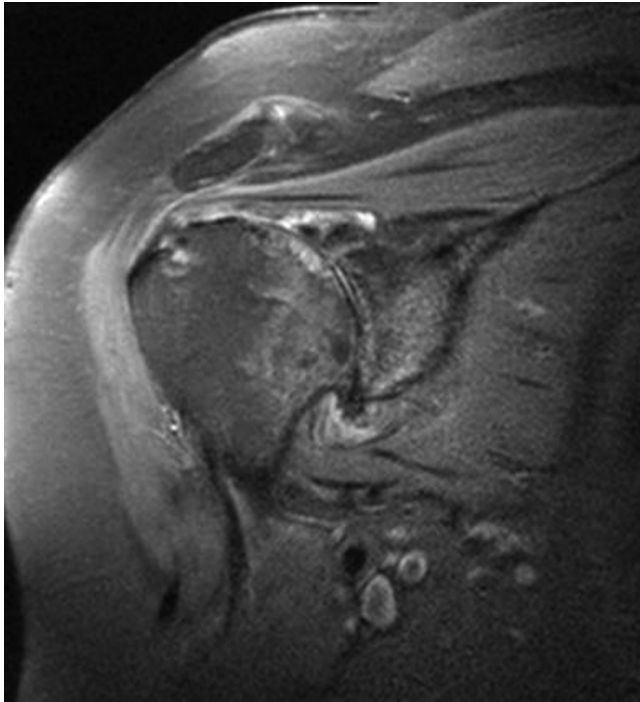
Figure 1 Partial rotator cuff tear.

There were no cases of stem loosening at 5-year follow-up, although 22% of patients (n = 8) had evidence of glenoid osteolytic lesions at 5 years. Moreover, 16% (n = 6) demonstrated grade 1 Lazarus changes and 5% (n = 2) showed grade 2 Lazarus changes. However, no patients showed grade 3 Lazarus changes.

Clinically, only 4 patients (11%) were noted to have weakness of the rotator cuff on cuff power assessment at 5 years (Fig. 2), evidenced by a reduction in power by 1 Medical Research Council grade, compared with previous postoperative assessment at 1 year. However, of these 4 patients, only 2 (5%) demonstrated evidence of proximal migration radiologically within the follow-up period. These 2 patients showed a reduction in forward flexion and external rotation > 20°. One of the patients who demonstrated cuff weakness and a reduction in ROM also showed a 10-point reduction in the OSS and proximal migration of the humerus, warranting revision to a reverse total shoulder replacement. Another of these patients had moderate migration with some anterior translation at 5 years, with the decision on revision pending. The other 2 patients who had weakness remained satisfied with the outcome. The 4 patients with clinical cuff weakness all had grade 2 partial-thickness tears and a Goutallier classification of grade 3. Thirty-four patients maintained power and ROM across clinical assessments and at 5 years. One patient needed washout and the DAIR (débridement, antibiotics, and implant retention) procedure for infection within the first 6 weeks of surgery; following a course of intravenous antibiotics, this treatment cleared the infection clinically.

Table II Comparison of preoperative and postoperative (5-year) range of movement

Movement	Preoperative (N = 36)	Postoperative (5 yr) (N = 36)	P value[*]
Forward flexion, °	80	140	.015
External rotation, °	20	40	.001
Abduction, °	45	90	.016

[*] Paired t test.

Discussion

The results of this study demonstrate that good medium-term results can be achieved in patients undergoing anatomic total shoulder replacement who have proven partial cuff tears. All patients reported an improvement in pain, and objectively, there was a significant improvement in postoperative range of motion. Despite established partial cuff tears, arthroplasty survivorship was not impacted, with >90% of patients retaining their prostheses at 5 years, similar to other published survival rates for anatomic total shoulder arthroplasty.[3,19] Our study suggests that surgeons should consider anatomic total shoulder replacement as a first-line procedure in patients with established partial rotator cuff tears. In addition, anatomic total shoulder replacement is a more cost-effective way of treating this cohort of patients.[16]

In recent years, there has been an increase in the number of reverse shoulder replacements being performed for primary osteoarthritis in the setting of partial rotator cuff tears and degenerative changes in the cuff. They are more likely to be performed in patients aged > 75 years.[18] This is often the case to minimize the need for a potential revision operation in the near future, with the general feeling among surgeons that the cuff integrity is likely to fail and degenerate further, leading to migration and subluxation of the implant. However, reverse shoulder replacement has been associated with increased complications in comparison to anatomic shoulder replacement, with the overall complication rate reported at approximately 15%.[2] Infection rates in particular are increased, with reported rates of up to 4% for reverse shoulder replacement compared with 1.1% for anatomic total shoulder replacement.[20] In a recent study, the infection rate for reverse shoulder replacement was reported to be as high as 8% in male patients.[13] In addition to increased complications, performing a reverse shoulder replacement in this population may reduce revision options available to surgeons in the future. This is particularly pertinent given the increasing popularity of the use of short-stem or stemless anatomic shoulder replacements, which provide greater preservation of bone stock and potentially enable easier revision options, if required. In our study, we demonstrate that patients aged ≥ 75 years had good outcomes following anatomic total
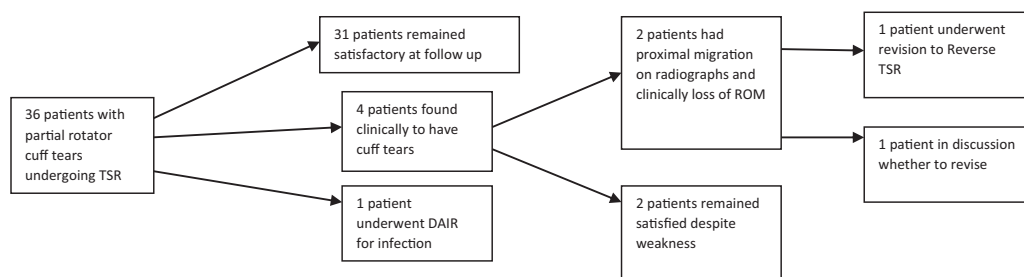
Figure 2 Summary of patient outcomes at 5-year follow-up. *TSR*, total shoulder replacement; *DAIR*, débridement, antibiotics, and implant retention; *ROM*, range of movement.

shoulder replacement, and given the reported higher morbidity of the reverse shoulder replacement procedure,[20] as well as greater cost of implants, surgical equipment, operative time, and readmission,[11] anatomic total shoulder replacement is a justifiable choice in this cohort.

Several studies have reported early failure of anatomic total shoulder replacement in patients with significant rotator cuff deficiency, which results in an upward migration of the prosthetic humeral head, causing loosening of the glenoid component by the rocking-horse phenomenon.[6,12,19,24] Given these reports and the concern that cuff tears may lead to increased revision rates, strict consideration should be given to surgical technique, including meticulous repair of the subscapularis, correct head sizing to prevent overstuffing the joint, and a carefully performed neck cut to ensure that an adequate rim of articular cartilage remains away from the cuff insertion to avoid tear progression (Fig. 3).

To ensure a rigorously conducted study and to increase the quality of our data, we supplemented the data by reviewing patient notes to search for missing data and ensure a complete 5-year follow-up case series. The diagnosis of full- and partial-thickness cuff tears on MRI scans has been shown to be reliable, but the reliability of grading partial-thickness tears remains low.[9,21] In our study, the tear grade and amount of fatty infiltration and muscle atrophy did not appear to have a significant association with clinical outcomes. This finding would be in keeping with the available evidence that suggests there is no influence of fatty infiltration and muscle atrophy on the outcome following total shoulder replacement.[17]

Previous studies investigating anatomic shoulder replacement in the presence of partial-thickness rotator cuff tears have reported only shorter-term outcomes.[5] This cohort study is the first, to our knowledge, to examine the medium- to long-term effect of partial cuff tears on outcomes in patients who underwent anatomic total shoulder arthroplasty for primary shoulder osteoarthritis. The study findings support previous evidence that partial cuff tears do not affect postoperative range of motion or patient-reported outcome measures.[5]

Our study has limitations. We are aware that our sample size was small and our results were derived from a single center. As a consequence, readmission data may not be complete if patients attended other hospitals with complications. However, all patients were actively followed up for 5 years, and patients mostly resided within the hospital catchment area. In addition, we were not able to assess the integrity of the rotator cuff at follow-up radiologically because of difficulty in imaging by artifact interference from the prosthesis; our radiology colleagues concurred that providing accuracy on cuff integrity was challenging using both ultrasound scans and MRI owing to prosthetic interference. However, we believe that clinical examination for the diagnosis of cuff tears has good sensitivity and specificity.[8] We did not use the Constant score as an outcome measure because we believe the power-assessment part of the score in this cohort could be unreliable[23] and the OSS is a validated and widely used score.[1] In addition, we did measure the ROM and regularly assess the rotator cuff clinically.

We appreciate that applying an age minimum of 75 years can appear arbitrary. We wanted to capture the elderly population. Although controversial, 75 years is a reasonable reflection of the elderly population at present.[15] We defined 75 as an age where clinicians often want to perform an operation that they feel will last the patient for their lifetime

Figure 3 Articular rim away from neck cut and tendon insertion.

and therefore likely to offer a reverse shoulder replacement, in the presence of a partial cuff tear, than perhaps a younger patient.

Conclusion

We report good medium- to long-term outcomes in patients aged $\geq$ 75 years undergoing anatomic total shoulder arthroplasty with partial-thickness rotator cuff tears. In the context of increased complications reported with reverse total shoulder replacement compared with anatomic total shoulder replacement, performing anatomic total shoulder replacement in the first instance may result in less morbidity to the patient, as well as reduced cost, and may afford the surgeon more revision options if required for future operations. This study suggests that surgeons treating patients with osteoarthritis in the presence of partial-thickness rotator cuff tears should consider an anatomic total shoulder replacement and that the increasing trend of reverse shoulder replacements in this cohort is not justified.

Disclaimer

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