Massive Rotator Cuff Tears in Patients Older Than Sixty-five: Indications for Cuff Repair versus Reverse Total Shoulder Arthroplasty

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The treatment of patients with massive rotator cuff tears (MCTs) without osteoarthritis is challenging. This population is of considerable interest, as the prevalence of MCT has been reported to be as high as 40% of all rotator cuff tears.[1] Options for surgical treatment in patients who have failed conservative management are numerous and include tendon debridement, partial or complete arthroscopic or open rotator cuff repair (RCR), tendon transfers, reverse total shoulder arthroplasty (rTSA), arthroscopic superior capsular reconstruction (ASCR), and other grafting procedures.[2] Arthroscopic superior capsular reconstruction shows promise as a novel technique, but it is not yet well studied. Other procedures such as tendon transfers fit into the treatment algorithm for only a small subset of patients. Open rotator cuff repair and rTSA are the 2 most commonly utilized procedures for MCT, and both have been shown to reliably achieve significant functional improvement and patient satisfaction.[3-6]

The dilemma for the treating surgeon is deciding which patients to treat with RCR and who to treat with rTSA. Predicting which surgical procedure will provide a better functional result is difficult and controversial.[7] The RCR method is a bone-conserving procedure with relatively low surgical risk and allows the option for rTSA to be performed as a salvage surgery should repair fail. It also may be less costly in the appropriate population.[8] However, large rotator cuff tears in elderly patients have low healing potential, and the prospect of participating in a lengthy rehabilitation after an operation that may not prove successful can be deterring.[9,10] In the elderly population, rTSA may be a reliable option, as tendon healing of the cuff is not necessary to restore function.

However, rTSA does not conserve bone, provides a non-anatomic solution, and has had historically high complication rates.[4,5]

In an effort to aid in the decision-making process when considering these 2 surgical options, we compared RCR and rTSA performed at a single institution for MCT in patients >65 years. Our aim was to identify preoperative patient variables that influence a surgeon's decision to proceed with 1 of the 2 procedures. Moreover, we evaluated clinical outcomes in these 2 patient populations. We hypothesized that (1) patients selected for rTSA would have worse preoperative function, less range of motion, more comorbidities, more evidence of radiographic subluxation, and a higher likelihood of having undergone previous RCR than those selected for RCR, and (2) both RCR and rTSA would be successful and result in improved clinical outcomes with high patient satisfaction.

MATERIALS AND METHODS

Patient Selection

We performed a retrospective chart review using our practice database of all patients undergoing arthroscopic RCR and rTSA for any indication by the senior author (M.A.F.) between January 2004 and April 2015. A total of 1503 RCRs and 1973 rTSAs were conducted during the study period. Patient medical records were reviewed, and those meeting the following criteria were included in the study: >65 years at the time of surgery, MCT, no preoperative glenohumeral arthritis, minimum follow-up of 12 months, functional deltoid muscle on physical examination, and no prior shoulder surgery except for RCR or diagnostic arthroscopy. A total of 92 patients who underwent arthroscopic RCR and 89 patients who underwent rTSA met the inclusion criteria. For patients with bilateral shoulder surgery, we measured each shoulder independently. Three patients underwent bilateral rTSA, and 3 patients underwent bilateral RCR, leaving 95 shoulders in the RCR group and 92 in the rTSA group. The Western Institutional Review Board determined this study to be exempt from review.

Radiographic Evaluation

All patient charts included a radiology report and documented interpretation of the images by the treating surgeon prior to surgery. Radiographs were assessed to assure the absence of preoperative glenohumeral osteoarthritis. The images were also graded based on the Hamada classification.[11] Stage 1 is associated with minimal radiographic change with an acromiohumeral interval (AHI) >6 mm; stage 2 is characterized by narrowing of the AHI <6 mm; and Stage 3 is defined by narrowing of the AHI with radiographic changes of the acromion. Stages 4 and higher include arthritic changes to the glenohumeral joint, and they were not included in the study population. The AHI measurements and the presence or absence of glenohumeral subluxation were documented.

Massive Cuff Tear Determination

We defined MCT on the basis of previously described criteria of tears involving ≥2 tendons or tears measuring ≥5 cm in greatest dimension.[12,13] Patient charts were screened, and those whose clinical notes or radiology reports indicated an absence of MCT were excluded. Preoperative imaging of the remaining patients was then evaluated by 3 fellowship-trained shoulder surgeons to confirm MCT in all patients with a clinically documented MCT, as well as to assess those who had insufficient documentation of tear size in the notes.

Advanced imaging was evaluated for fatty atrophy of the rotator cuff musculature, and Goutallier classification

was assigned.[14,15] Length of retraction was measured from the tendon end to the medial aspect of the footprint on coronal imaging, and the subscapularis and teres minor were assessed and documented as torn or intact.[16,17]

Data Collection

We reviewed clinical charts and patient questionnaire forms from both the preoperative and follow-up visits. Clinical data collected included gender, age at surgery, active range of motion (forward elevation, abduction, external rotation, and internal rotation), comorbidities, smoking status, BMI, history of shoulder surgery, and any postoperative complications or need for secondary surgery. All patients completed patient-centered questionnaires regarding shoulder pain and dysfunction at each visit or via telephone communication with clinic staff. Outcome measurements used for analysis included American Shoulder and Elbow Surgeons (ASES) Score, simple shoulder test (SST), visual analog score (VAS) pain scale, and patient-reported satisfaction (Graded 1-10; 1 = poor outcome; 4 = satisfactory outcome; 7 = good outcome; 10 = excellent outcome).

Data Analysis and Statistical Methods

Statistical tests were selected based on the result of Shapiro–Wilk test for normality. Continuous variables were evaluated with either independent *t* test or Mann–Whitney U test. Dependent *t* test was used to evaluate outcome variables. For categorical variables, either Pearson's χ^2or Fisher's exact test was performed depending on the sample size. Alpha was set at $P = .05$.

RESULTS

Preoperative Characteristics

Of the 187 shoulders in the study group, 95 had RCR and 92 had rTSA. Demographic information and preoperative variables for both groups are summarized in **Table 1** and **Table 2**. Patients in the RCR group had greater preoperative forward elevation, abduction, and external rotation and higher preoperative functional scores than those in the rTSA group. Patients in the rTSA group were older and more likely to be female than those in the RCR group. More patients in the rTSA group had undergone prior RCR compared with those in the RCR group. Each of these differences was statistically significant. Subjective pain scores, BMI, and comorbidities were similar between the 2 groups.

Radiographically, patients selected to undergo rTSA had a smaller AHI (4.8 vs 8.7, $P < .0001$) and more evidence of superior subluxation (50.6% vs 14.1%, $P < .0001$) than those in the RCR group. Average Hamada grade was 1.4 ± 0.7 and 2.2 ± 0.7 for the RCR and rTSA groups, respectively ($P < .0001$). Average Goutallier grade was similar between the groups (2.2 ± 0.6 for RCR vs 2.2 ± 0.8 for rTSA, $P = .227$), and 25.5% of the RCR group had Grade 3 or 4 atrophy compared with 28.1% of the rTSA group.

Postoperative Outcomes

The average follow-up time was 44 months for RCR and 47 months for rTSA. Patients in the RCR and rTSA groups were highly satisfied with the surgery (8.5 ± 2.6 vs 8.2 ± 2.6, $P = .461$) and had significantly increased range of motion in all planes and improved functional scores (**Table 3**). The rTSA group had greater net improvement in forward elevation, abduction, and external rotation than the RCR group. Both groups demonstrated similar

improvement in ASES, SST, and VAS pain scores.

In the RCR group, 5 patients (5.3%) required reoperation: 3 patients underwent conversion to rTSA, 1 patient underwent biceps tenotomy with subacromial decompression, and 1 patient underwent arthroscopic irrigation and debridement for a postoperative *Propionibacterium acnes* infection. In the rTSA group, 2 patients (2.2%) required reoperation: 1 patient underwent open reduction internal fixation for a scapula fracture that failed conservative management, and 1 patient had an open irrigation and debridement with polyethylene exchange for an acute postoperative infection of unknown source.

DISCUSSION

Massive, retracted rotator cuff tears are a common and difficult problem.[1] The treatment options are numerous and depend on a variety of preoperative factors including patient-specific characteristics and factors specific to the tear. For certain patients, nonoperative management may be a reasonable first step, as an MCT does not necessarily preclude painless, functional shoulder motion. Elderly, lower demand individuals have been shown to do well with physical rehabilitation.[18] Similarly, for the same category of elderly patients who do not respond to conservative measures, arthroscopic tendon debridement with or without subacromial decompression and/or biceps tenotomy may be effective.[1,19] This technique has been described as “limited goals surgery;” despite some mixed results in the literature, multiple studies have reported symptomatic and functional improvement after simple debridement.[2,19–21] The consensus among several authors has been that this procedure continues to play a role for elderly, low-demand patients whose functional goals are limited and whose primary complaint is pain.[1,2,20]

For the majority of patients with MCT who desire pain relief and a restoration of shoulder function, RCR remains the gold standard of treatment and should be the primary aim if feasible. Complete RCR has consistently outperformed both partial repair and debridement in multiple studies in terms of pain relief and functional improvement.[10,21,22] However, elderly patients with chronic, massive tears, particularly in the setting of muscle atrophy, are at high risk of failure with attempted cuff repair.[9,23] Novel techniques such as superior capsular reconstruction and subacromial balloon spacer implantation may offer a minimally invasive method of re-centering the humeral head and stabilizing the glenohumeral joint; however, these new treatment options lack any long-term data in the literature to support their widespread use.[24–26] Alternatively, rTSA has been shown to be a reliable option to restore shoulder function in the setting of a massive irreparable rotator cuff tear, even in the absence of arthritis.[5,27-31]

The decision-making process for selecting RCR or rTSA in the setting of MCT without arthritis in the older population (age >65 years) remains challenging. We attempted to quantify the data of a high-volume surgeon and identify the differences and similarities between those patients selected for either procedure. At our institution, we generally performed rTSA on patients with low preoperative range of motion, poor function based on SST and ASES scores, small AHI, and strong evidence of superior subluxation. We were also more likely to perform rTSA if the patient had a history of rotator cuff surgery. There was a predilection for older age and female gender in those who underwent rTSA.

For our study, we elected to focus on patients >65 years. In our experience, the choice of which surgical procedure to perform is generally easier in younger patients. Most surgeons appropriately opt for an arthroscopic procedure or tendon transfer to preserve bone and maintain the option of rTSA as a salvage procedure if necessary in the future. Studies have reported that <60 years is a predictor of poor outcome with rTSA, and patients <65 years who undergo rTSA have been shown to have high complication rates.[30-32] Furthermore, the longevity of the implant in young patients is a significant concern, and revision surgery after rTSA is technically

demanding and known to result in poor functional outcomes.[32,33]

Although the indications for rTSA are expanding, attempts at RCR in the setting of MCT remain largely appropriate. Preserved preoperative anterior elevation >90° has been associated with loss of motion after rTSA and poor satisfaction, and one should exercise caution when considering rTSA in this setting.[3] The current study confirmed that even older patients with MCT may be very satisfied with arthroscopic RCR **(Figure 1).** Both range of motion and function significantly improved, and patients were largely satisfied with the procedure with an average self-reported outcome of good to excellent. At the time of final follow-up for this study, only 3 shoulders in the RCR group had undergone conversion to rTSA. This number may be expected to rise with long follow-up periods, and we feel that prolonging the time before arthroplasty is generally in the best interest of the patient.

Our results were consistent with several reported studies in which RCR has been shown to be successful in the setting of MCT.[34–37] Henry and colleagues[36] performed a systematic review that evaluated 954 patients who underwent partial or complete anatomic RCR for MCT. Although the average age was 63 years (range, 37–87), functional outcome scores, VAS pain score, and overall range of motion consistently and significantly improved.

rTSA may be a “more reliable” option than RCR in treating MCT in the older population because it does not rely on tendon healing. However, the relationship between tendon healing and clinical outcomes after RCR is unclear. The aforementioned systematic review reported re-tear rates to be as high as 79%, but several studies have reported high satisfaction even in the setting of retear.[36] Yoo and colleagues[38] and Chung and colleagues[9] reported re-tear rates of 45.5% and 39.8%, respectively, but both studies noted that there was no difference in outcome measures between those patients with and without re-tears. In particular, for patients who have had no prior rotator cuff surgery, an attempt at arthroscopic repair may be a prudent option with relatively low risk.

Although certain patients may clinically improve despite suffering a re-tear (or inability to heal in the first place), others continue to experience pain and dysfunction that negatively affect their quality of life.[39–41] These patients are more often appropriate candidates for rTSA. Indeed, several studies have demonstrated a higher re-tear rate in patients with a history of surgery than in those without.[23,31,38,42] Shamsudin and colleagues[43] found revision arthroscopic RCR, even in a younger age group with tears of all sizes, to be twice as likely to re-tear. Notably, re-tear after revision repair may be more likely to be symptomatic, as these re-tears are routinely associated with pain, stiffness, and loss of function. Even in the hands of experienced surgeons in a younger population, revision repair has only been able to reverse pseudoparalysis in 43% of patients, leading to only 39% return to sport or full activity.[44] In examining our data, we were much less likely to perform an RCR in patients who had a history of cuff repair surgery than in those without this history.

Overall, those patients selected for rTSA in our study population performed well postoperatively **(Figure 2** and **Figure 3).** Vast improvements were noted in range of motion, function, and pain scores at final follow up. Moreover, no patients in the study group required revision arthroplasty during the follow-up period. Although the average follow-up period was only 47 months, these results suggested that elderly patients with MCT without arthritis may be particularly ideal candidates for rTSA with regard to implant survival and anticipated revision rate when chosen appropriately.

Several weaknesses were noted within this paper. First, the study was retrospective, precluding randomization of treatment groups and standardization of data collection and follow-up. The outcomes of RCR and rTSA could not be compared directly due to the inherent selection bias. The groups clearly differed in many respects, and these preoperative factors likely played a role in postoperative outcomes. However, the primary goal of this study was not to compare outcomes of the treatment groups but to analyze the patterns of patient selection by an experienced treating surgeon and contribute to published data that each surgery can be successful in this patient

population when chosen appropriately.

Second, our data were based on a single surgeon's decisions, and results may not be generalizable. Furthermore, the senior author has had a longstanding interest in reverse shoulder arthroplasty and has published data illustrating successful outcomes for rTSA in patients with MCT. For this reason, one could presume that there may have been some bias toward treating patients with rTSA. However, we feel that the senior author's unique and longstanding experience in treating MCT allows for a thorough evaluation and comparison of preoperative variables and outcomes declared within this study. Indeed, many patients included in this study were referred from outside institutions specifically for rTSA but instead were deemed more appropriate candidates for RCR and underwent successful arthroscopic repair, a common scenario which served as an impetus for this study.

Conclusion

RCR and rTSA are both viable options for patients >65 years with MCT without arthritis. Treatment must be individualized for each patient with careful consideration of a number of preoperative variables and patient characteristics. At our institution, patients with previous RCR, decreased range of motion, poor function, and strong radiographic evidence of subluxation are more likely to undergo rTSA. When chosen appropriately, both RCR and rTSA can result in improved range of motion, function, and high patient satisfaction in this patient population.

Key Info

Key Info:

Take-Home Points

- Rotator cuff repair and reverse total shoulder arthroplasty are both viable options for patients >65 years with massive rotator cuff tears without arthritis.
- Treatment must be individualized for each patient, with careful consideration of a number of preoperative variables and patient characteristics.
- At our institution, patients with previous rotator cuff repair, decreased range of motion, poor function, and strong radiographic evidence of subluxation were more likely to undergo reverse total shoulder arthroplasty.
- Patients selected for rotator cuff repair had greater preoperative flexion, abduction, and external rotation, as well as higher functional scores, and were less likely to have had previous cuff surgery.
- When chosen appropriately, both rotator cuff repair and reverse total shoulder arthroplasty can result in improved range of motion, function, and high patient satisfaction in this patient population.

Figures/Tables

Figures / Tables:

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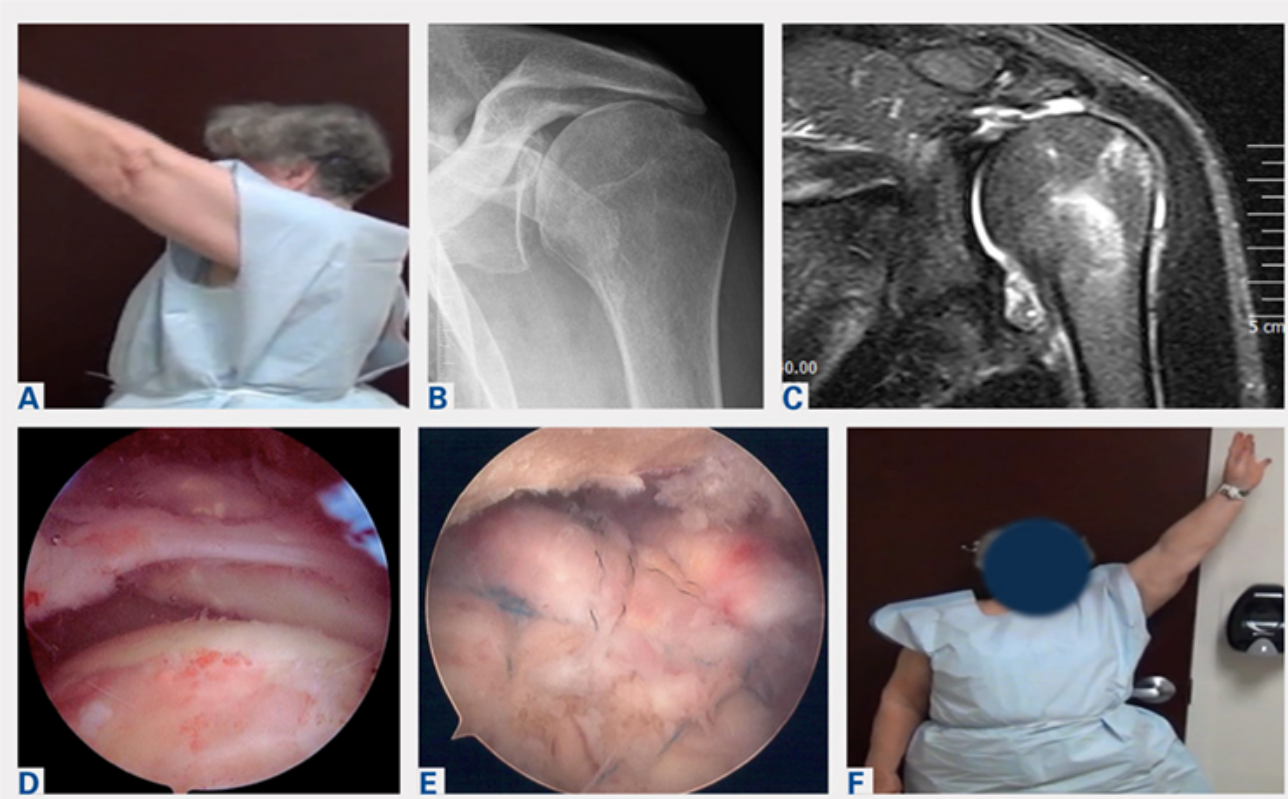

Figure. 1. A 76-year-old female presented with a painful left shoulder and limited range of motion. On examination, she had active forward elevation >90 (a), radiographs showed a narrowed acromiohumeral interval but preserved glenohumeral joint space (b), and magnetic resonance imaging revealed a massive, retracted rotator cuff tear (c). She underwent successful arthroscopic rotator cuff repair (d, e) with resolution of her pain and improved range of motion (f).

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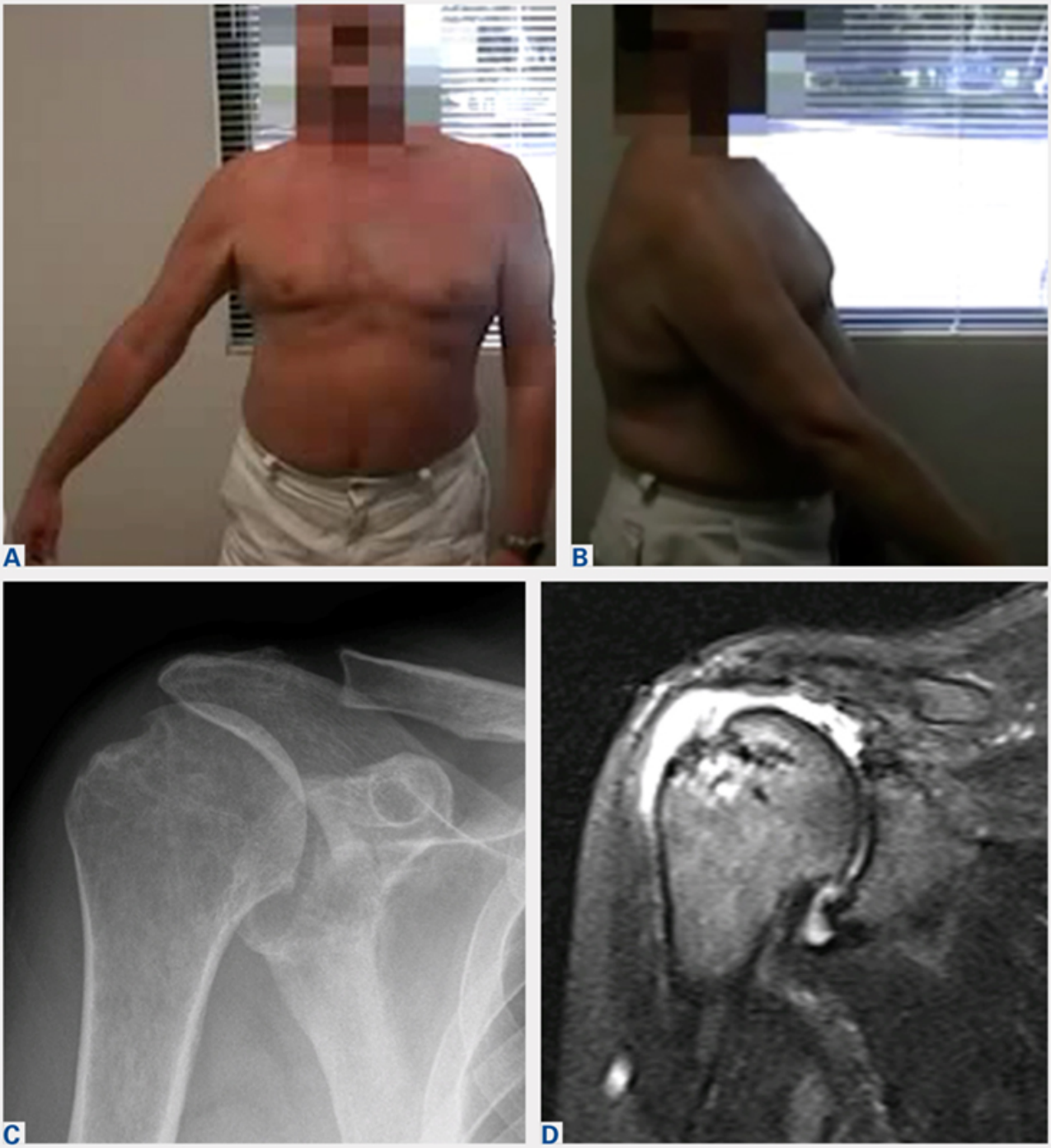

Figure. 2. A 69-year-old male presented with right shoulder pain and markedly limited function and range of motion (a, b). He had a history of arthroscopic rotator cuff repair. Radiographs showed superior migration of the humeral head without evidence of arthritis (c), and magnetic resonance imaging revealed a massive rotator cuff tear.

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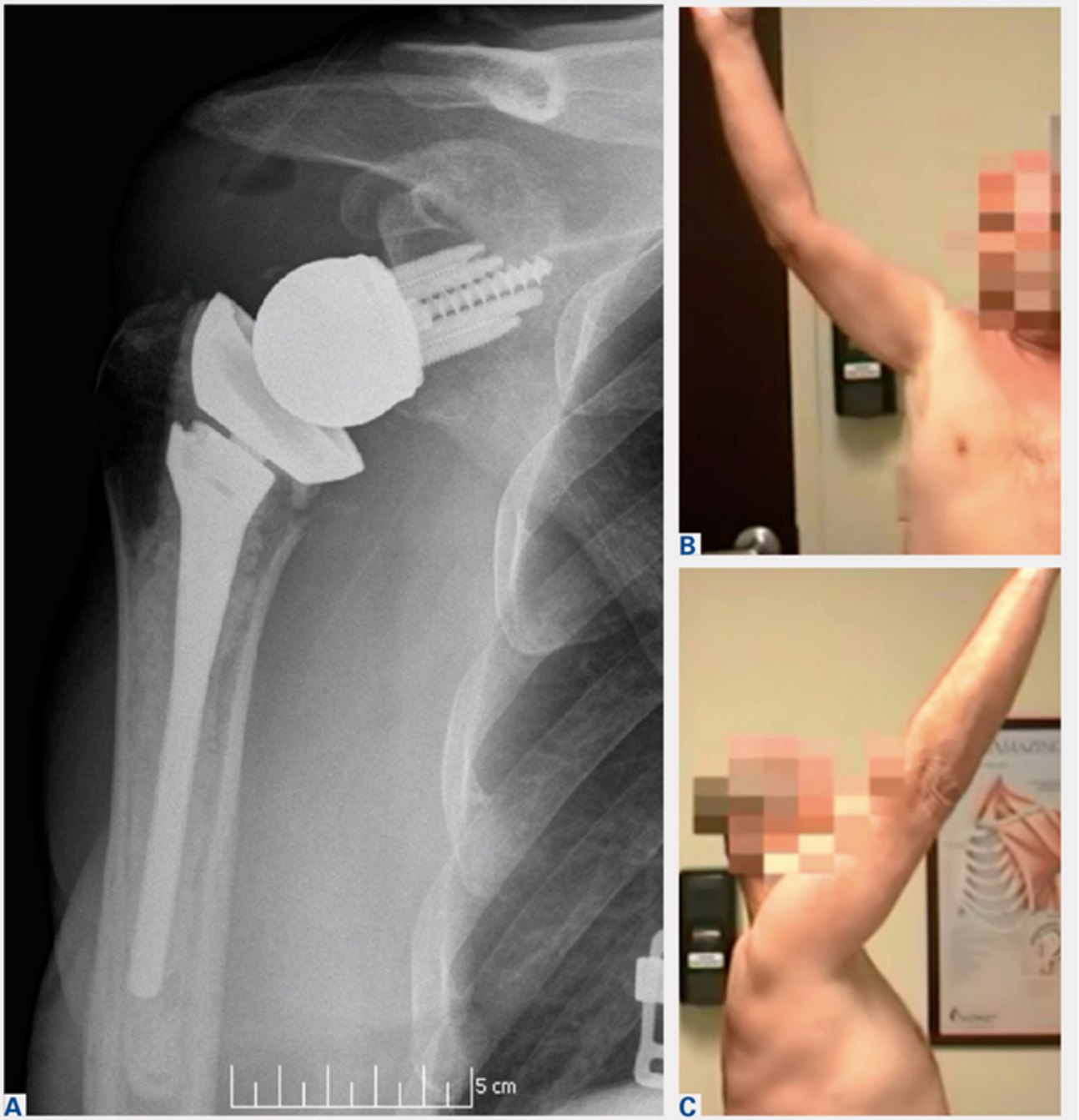

Figure. 3. The patient in Figure. 2 underwent successful reverse total shoulder arthroplasty (a) with restoration of functional shoulder motion (b, c).

Table 1. Patient demographics

	RCR	rTSA	*P* value

Age (yr; mean ± SD)	71 ± 5	74 ± 6	<.0001
Gender *male (no.; %) *female (no.; %)	57 (60%) 38 (40%)	30 (33%) 62 (67%)	<.0001
BMI (mean ± SD)	28.5 ± 4.4	28.1 ± 4.5	.578

Abbreviations: BMI, body mass index; RCR, rotator cuff repair; rTSA, reverse total shoulder arthroplasty.

Table 2. Preoperative variables

	RCR (n=95)	rTSA (n=92)	*P* value
Radiographic parameters			
AB interval	9 ± 3	5 ± 3	**<.0001**
Humeral escape	14.1%	50.6%	**<.0001**
Hamada 1	76.1%	15.6%	
Hamada 2	13.0%	50.6%	**<.0001**
Hamada 3	10.9%	33.8%	
Goutallier grade 1	7.8%	19.3%	
Goutallier grade 2	66.7%	52.6%	.227
Goutallier grade 3	21.6%	19.3%	
Goutallier grade 4	3.9%	8.8%	
Clinical measures			
Preop FE	113 ± 50	57 ± 34	**<.0001**
Preop AB	97 ± 45	53 ± 35	**<.0001**
Preop ER	42 ± 25	32 ± 28	**.029**
Preop IR	2.9 ± 1.6	2.6 ± 1.8	.247
Preop pain	5.7 ± 2.3	5.6 ± 2.5	.927
Preop ASES	44 ± 17	39 ± 16	**.04**
Preop SST	3.1 ± 2.6	1.9 ± 1.7	**.001**
Patients parameters			
Previous cuff surgery	6.3%	35.9%	**<.0001**
Comorbidity count	1.7 ± 1.4	2.1 ± 2.7	.126

Abbreviations: AB, abduction; ASES, American Shoulder and Elbow Society score; ER, external rotation; FE, forward elevation; IR, internal rotation; preop, preoperative; SST, simple shoulder test.

Table 3. Postoperative outcomes

	RCR (n=95) Preoperative	Postoperative	*P* value	rTSA (n=92) Preoperative	Postoperative	*P* value
FE	113 ± 50	166 ± 26	<.0001	57 ± 34	136 ± 46	<.0001
AB	97 ± 45	155 ± 37	<.0001	53 ± 35	129 ± 44	<.0001
ER	42 ± 25	48 ± 20	.033	32 ± 28	57 ± 32	<.0001
IR	2.9 ± 1.6	4.6 ± 1.6	<.0001	2.6 ± 1.8	4.7 ± 2.4	<.0001
VAS pain	5.7 ± 2.3	1.7 ± 2.4	<.0001	5.6 ± 2.5	1.6 ± 2.5	<.0001
ASES	44 ± 17	83 ± 18	<.0001	39 ± 16	77 ± 22	<.0001
SST	3.1 ± 2.6	9.3 ± 2.9	<.0001	1.9 ± 1.7	7.1 ± 3.4	<.0001

Abbreviations: AB, abduction; ASES, American Shoulder and Elbow Society score; ER, external rotation; FE, forward elevation; IR, internal rotation; SST, simple shoulder test; VAS – visual analog score.

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Multimedia

Product Guide

Product Guide

- STRATAFIX™ Symmetric PDS™ Plus Knotless Tissue Control Device
- STRATAFIX™ Spiral Knotless Tissue Control Device
- BioComposite SwiveLock Anchor
- BioComposite SwiveLock C, with White/Black TigerTape™ Loop

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