Rotator Cuff Repair in Patients with Inflammatory Arthritis: Satisfactory Mid-Term Outcomes

Daniel C. Austin, MD MS, Ryan R. Wilbur, MD, Thomas H. Rogers, MD, Jonathan D. Barlow, MD, Christopher L. Camp, MD, Mark E. Morrey, MD, John W. Sperling, MD, Joaquin Sanchez-Sotelo, MD PhD

PII: S2666-6383(22)00186-4

DOI: https://doi.org/10.1016/j.jseint.2022.08.019

Reference: JSEINT 664

To appear in: *JSES International*

Received Date: 25 August 2022

Accepted Date: 30 August 2022

Please cite this article as: Austin DC, Wilbur RR, Rogers TH, Barlow JD, Camp CL, Morrey ME, Sperling JW, Sanchez-Sotelo J, Rotator Cuff Repair in Patients with Inflammatory Arthritis: Satisfactory Mid-Term Outcomes, *JSES International* (2022), doi: https://doi.org/10.1016/j.jseint.2022.08.019.

Rotator Cuff Repair in Patients with Inflammatory Arthritis: Satisfactory Mid-Term Outcomes

Running title: Rotator Cuff Repair with Arthritis Diagnoses

Daniel C. Austin MD MS, Ryan R. Wilbur MD , Thomas H. Rogers MD , Jonathan D. Barlow MD , Christopher L. Camp MD , Mark E. Morrey MD , John W. Sperling MD, Joaquin Sanchez-Sotelo MD PhD

From: Orthopedic Department, Mayo Clinic, 200 First St. SW, Rochester MN 55905, USA

Corresponding author:

Joaquin Sanchez-Sotelo MD

200 First St SW

Rochester MN 55905, USA

Sanchezsotelo.joaquin@mayo.edu

Disclaimers:

Funding: No funding was disclosed by the authors.

Conflicts of interest:

The authors, their immediate families, and any research foundation with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.

The Mayo Clinic Institutional Review Board approved this study. IRB: 20-009585

Abstract

Purpose:

We aimed to evaluate mid-term patient reported outcomes and re-operation rates following rotator cuff repair in patients with either rheumatoid arthritis (RA) or other inflammatory arthritis (nonRA-IA) diagnoses.

Methods:

We identified all patients with either RA or nonRA-IA who underwent a rotator cuff repair at our institution between 2008 and 2018. IA diagnoses included RA, systemic lupus erythematosus, psoriatic arthritis, and other unspecified inflammatory arthritis. We compiled a cohort of 51 shoulders with an average follow-up time of 7.0 years. The average age was 60 years (range 39-81) and 55% of patients were female. Patients were contacted by phone to obtain patient reported outcomes surveys. Univariate linear regression was used to evaluate associations between patient characteristics and outcomes.

Results:

Review of preoperative radiographs demonstrated that 50% of patients presented with some degree of glenohumeral joint inflammatory degeneration. At final follow-up, the mean visual-analogue score for pain was 2 (range 0-8) and the mean American Shoulder and Elbow Surgeons score (ASES) was 77 (SD = 19). The mean subjective shoulder value was 75 percent (SD = 22%), and average satisfaction was 9 (SD 1.9). The mean Patient-Reported Outcomes Measurement Information System upper extremity (PROMIS-UE) was 41 (SD = 10.6). Female sex and a complete tear (vs. partial) were both associated with lower ASES scores, while no other characteristics were associated with postoperative ASES scores. The 5-year Kaplan-Meier survival estimate free of reoperation was 91.8% (95% CI 83.0 – 99.8).

Conclusions:

Rotator cuff repair in patients with rheumatoid arthritis or other inflammatory arthritis diagnoses resulted in satisfactory patient reported outcomes that seem comparable to rotator cuff repair when performed in the general population. Further, re-operations were rare, with a 5-year survival rate free of reoperation for any reason of over 90%. Altogether, an inflammatory arthritis diagnosis should not preclude by itself attempted rotator cuff repair surgery in these patients.

Level of Evidence: Level IV; Case Series; Treatment Study

Key words: Rotator Cuff Repair;Inflammatory Arthritis;Outcomes;RA;nonRA-IA;rheumatoid arthritis

Rheumatoid arthritis (RA) is an autoimmune condition that affects approximately 1% of the population [1] with a predilection for women over men [5]. The effects of RA or other non-rheumatoid inflammatory arthritis (nonRA-IA) diagnoses, such as lupus or psoriatic arthritis, on the glenohumeral joint have long been recognized,[5, 11] with over 90% of patients with longstanding RA reported to develop shoulder pathology[5]. The inflammatory changes associated with RA and nonRA-IA can damage the bone, cartilage and soft tissues about the shoulder, and a substantial percentage of patients may develop rotator cuff tears[17].

Rotator cuff tear is a common diagnosis in shoulder IA, and is reported in nearly 50% of individuals in the general population with shoulder symptoms[20]; 20% of these patients ultimately undergo surgery[12]. In general, utilization of rotator cuff repair has continued to grow[3], becoming one of the most common orthopedic procedures in the United States[8]. Surgical treatment of rotator cuff tears has produced favorable results in patients with full-thickness tears[19], although the magnitude of benefit remains controversial[18]. One of the challenges of rotator cuff repair

(RCR) is a significant re-tear rate following surgery of up to 50% in large tears[1, 24] which can lead to inferior clinical outcomes[1, 21].

Rotator cuff repair failure has been associated with fatty degeneration of the rotator cuff musculature[9,16], which plausibly affects the quality of the tissue available for repair. Similarly, patients with RA and nonRA-IA may have compromised soft tissues which could impact the healing potential of their tendons as well. The outcomes of rotator cuff repair in patients with IA has not been well-studied, with only 2 small retrospective studies reporting mixed results. In a prior study of patients with RA, the outcomes were unsatisfactory in 43% of patients with a full-thickness tear[22] while a more recent study found similar outcomes between patients with and without RA[13]. Over the last 20 years, novel biologically based medications better control the manifestations of IA[7], and it is possible that this innovation may influence modern-day outcomes of rotator cuff repair in these patients. We aimed to report on the mid-term clinical outcomes and reoperation rates in patients with either RA or other inflammatory arthritis. We hypothesized that their outcomes would be inferior to those generally found in the literature for patients with classic degenerative tears.

Methods

Study Population

This study was approved by our Institutional Review Board. Patients 18 years old and above who had undergone surgical treatment of a rotator cuff tear with a concomitant diagnosis of either rheumatoid arthritis, systemic lupus erythematosus (SLE), psoriatic arthritis, or other unspecified inflammatory arthritis were identified. The query was limited to procedures between 2008 and 2018 to allow for a minimum 2-year follow-up. During this period, we identified 56 shoulders in 52 eligible patients, 4 of whom were found to be deceased. We were able to contact

47 of 48 living patients (98%) by phone, ultimately reporting on 51 shoulders (4 bilateral) with a minimum follow-up of 2 years (mean 7.0 years; range 2.3-12.7).

Within the group of the 47 patients included, the average age was 60 (range 39-81) years and 55% of patients were female (Table 1). Overall, rheumatoid arthritis was the most common inflammatory arthritis (24 patients, 49%), while 11 patients (22%) presented with unspecified inflammatory arthritis, 8 (16%) with psoriatic arthritis, and 5 (10%) with SLE. 82% of patients were taking at least one anti-rheumatoid medication at the time of presentation, with 65% taking a corticosteroid, and 22% using a biologic immunomodulator, most commonly adalimumab (Humira^{TM}).

Outcomes of Interest

Patient demographics and preoperative characteristics were collected via chart review. Radiographic classification systems including Hamada and Larson in addition to measurements of rotator cuff tears were completed by two fellowship trained shoulder and elbow surgeons (DCA and THR) by consensus. Postoperative outcomes and reoperations were collected via phone interview and chart review. Outcomes of interest included pain ratings using a visual analogue scale, the American Shoulder and Elbow Surgeons Score (ASES) for shoulder, the Patient-Reported Outcomes Measurement Information System upper extremity computer adaptive test (PROMIS-UE), the subjective shoulder value (SSV), postoperative satisfaction, and pain medication use. Patients who ultimately underwent a shoulder arthroplasty (n=3) were not included in the aggregate outcomes scores, while those who underwent a revision soft tissue procedures or rotator cuff repair (n=2) were included.

Procedure Characteristics

All shoulders included in the study presented with a confirmed rotator cuff tear and underwent open (n=22, 44%) or arthroscopic (n=27, 55%) rotator cuff repair. Supraspinatus repair was completed in 95% of the shoulders, infraspinatus repair in 54% of the shoulders, and subscapularis repair in 12% of the shoulders. A complete repair was accomplished in 85% of the shoulders, while only a partial repair could be achieved in 15% of the shoulders. Suture anchors were utilized in 61% of patients and transosseous fixation was used in 32% of patients, while 8% of the repairs were performed by margin convergence. A concomitant biceps procedure was performed in 33% of patients, with biceps tenodesis (22.4%) being more common than tenotomy (10.2%). An acromioplasty was performed in 49% of cases.

Analysis

Data is presented using counts and percentages for categorical variables and means with standard deviations for continuous variables. A generalized linear regression model (GLM) was utilized to evaluate univariate associations between patient characteristics of interest and relevant postoperative outcomes. Survival free of reoperation was calculated using Kaplan-Meier survival analysis. In all analyses, a p-value <0.05 was considered statistically significant. All analyses were conducted using SAS version 9.4M6 (SAS Institute, Inc., Cary, NC, USA) and R version 3.6.2 (R Foundation for Statistical Computing, Vienna, Austria, 2019).

Results

Radiographic Characteristics

Altogether, radiographs were available for review in 48/51 (94%) of shoulders, while 47/51 (92%) of shoulders had MRI imaging available. Review of preoperative radiographs demonstrated that 50% of patients presented with inflammatory degenerative changes involving the glenohumeral joint. Glenohumeral changes secondary to inflammatory arthritis were

determined to be Larson grade 0 in 65%, grade 1 in 31%, and grade 3 in 4% of the shoulders. Additionally, 79% of shoulders were classified as Hamada 1, 19% were Hamada 2, and 2% had evidence of Hamada 3 changes related to their underlying rotator cuff tears (Table 2). The supraspinatus demonstrated a full thickness tear in 85% of the shoulders and partial thickness in 15%. The infraspinatus had no tear in 62% of shoulders, a full-thickness tear in 21% of shoulders, and partial thickness tearing in 17%. The subscapularis was intact in 51% of patients, had a full-thickness tear in 11%, and a partial thickness in 38% of shoulders. The average number of tendons torn was 1.8 (range 1-3) per shoulder. Fatty infiltration was graded as 0 in 61% of patients and grade 1 or 2 in 39% of patients using the Fuchs classification on MRI imaging.[6]

Patient Reported Outcomes

At most recent follow-up, the mean time since surgery was 7.0 years (range 2.3-12.7 years). The mean pain was 2 (range 0-8) and the mean ASES score was 77 (SD = 19; Table 3). The mean subjective shoulder value was 75 per cent (SD = 21.8%), and the average satisfaction score was 9 (SD = 1.9). The mean PROMIS Upper Extremity score was 40.8 (SD = 10.6). Altogether, 69% of patient were on prescription pain medications, although these were not necessarily prescribed for their shoulder pathology.

Univariate linear regression demonstrated that male sex was associated with a significantly higher ASES score (mean = 85) in comparison to females (mean = 71, $p = 0.01$). A complete rotator cuff repair was also associated with a higher ASES score (mean = 81) in comparison to partial repairs (mean = 59). With the numbers available, variables that were not associated with ASES scores included age, size of tear (mm^2), type of inflammatory arthritis, use of anti-rheumatic medications, use of corticosteroids, and a history of smoking. Patients with a Fuchs

fatty infiltration score of 1/2 had a mean ASES of only 72 in comparison to a mean of 82 in those without fatty infiltration, although this difference did not reach significance ($p = 0.09$). PROMIS-UE scores were also significantly higher in males (mean 46) vs. females (mean = 37, $p < 0.01$). With the numbers available, no other characteristics were significantly associated with PROMIS-UE scores. Univariate regression also demonstrated that pain scores were higher in those with a partial repair (mean = 4.2) vs. those with a complete repair (mean 1.8, $p = 0.02$). Additionally, patients with a Fuchs fatty infiltration score of 1/2 had a mean pain score of 3.1 in comparison to a mean of 1.6 in those without fatty infiltration ($p = 0.04$). Similarly, patient satisfaction was higher in those with a complete repair (mean = 9.3) versus those with a partial repair (mean = 7.8, $p = 0.03$). Average satisfaction also trended higher in males (mean = 9.6) versus females (mean = 8.8, $p = 0.05$). With the numbers available, no other characteristics were significantly associated with either pain intensity or satisfaction at most recent follow-up.

Reoperations

In total, 5 of 51 shoulders (9.8%) underwent reoperation. Two of these patients were treated with reverse shoulder arthroplasty procedures at 2.2 and 5.9 years following their index rotator cuff repair surgeries. One patient who experienced a re-tear was treated first with an anterior latissimus dorsi transfer to the lesser tuberosity for an irreparable subscapularis tear at 0.6 years from the index repair before being converted to a reverse shoulder arthroplasty at 5.3 years from the initial procedure. Two additional patients only required soft tissue procedures and were included within the patient reported outcomes analysis. One patient required a mini-open revision cuff repair at 0.4 years from the index procedure while the second underwent a biceps tenotomy at 0.4 years followed by an arthroscopic revision cuff repair for a traumatic re-tear at 5.7 years. Kaplan-Meier estimates for survival free of reoperation demonstrated a 93.9% (95%

CI 87.4 – 100.0) 1-year survival rate, a 91.8% (95% CI 83.0 – 99.8) 5-year survival rate, and an 88.4% (95% CI 77.4 – 98.9) 10-year survival rate. Based upon the size of the cohort and the low reoperation rate, there was not adequate statistical power to further investigate risk factors associated with failure.

Discussion

Inflammatory arthritis such as RA, and the medications used to treat these diagnoses including corticosteroids, can directly impact the bone and soft tissues around the glenohumeral joint. The impact of these factors on outcomes following rotator cuff repair in inflammatory shoulders is unclear. We aimed to further understand the outcomes of cuff repair surgery in inflammatory arthritis by collecting mid-term patient reported outcomes in a series of 51 shoulders treated at a single institution. Our results demonstrated generally positive outcomes, with an average ASES score of 77, a satisfaction score of 9 out of 10, and a Kaplan-Meier 5-year survival rate greater than 90%. Male sex, less fatty infiltration, and complete rotator cuff repairs were factors found to be associated with improved clinical outcomes. These results suggest that a concomitant diagnosis of inflammatory arthritis by itself should not disqualify these patients from consideration of rotator cuff repair when indicated. Furthermore, we did not find evidence supporting that anti-rheumatic medications, including corticosteroids, adversely impact outcomes.

There are limited studies in the literature to compare our results with. A previous study evaluating outcomes of rotator cuff repair in patients with RA reported on 23 shoulders who underwent surgery between 20 and 30 years ago[22]. At an average follow-up of 9.7 years, these authors reported a mean ASES score of 69, a mean pain score of 2, and a patient satisfaction score of 7. Altogether 35% of the shoulders were assigned an unsatisfactory result. Although the

average pain score is similar in our study, ASES scores (77) and patient satisfaction (9/10) were notably higher in the current study, although these differences may not exceed the minimal clinically important difference (MCID)[23]. The reason for these differences is unclear, but it may relate to better overall control of inflammatory arthritis symptoms with newer anti-rheumatic medications including biologic therapies[7], and possibly to improved surgical techniques and more common use of arthroscopic repair surgery in more recent years. The overall revision rate in the previous study of 8.7% is very similar to what we observed and suggests that differences in repair failures do not seem to be driving the differences in outcomes.

A more recent study compared 29 patients with RA undergoing rotator cuff repair to a group of matched controls without the disease[13]. At an average follow-up of 46 months, these authors reported similar outcomes in both groups. More specifically, they observed ASES scores of 78.1 and 85.5 and VAS pain scores of 2.5 and 1.8 in the RA and control groups respectively. Interestingly, the ASES and pain scores they observed in RA patients were very similar to what we reported in our series (ASES 77, VAS Pain 2.3) highlighting consensus between the studies. Although this study was smaller in scope than ours and utilized historical patients who did not have access to current anti-rheumatic therapies, it is notable that they were able to compare outcomes directly with non-RA patients and found no difference between groups. This bolsters the results of our case-series, since our patient reported outcomes mirrored those reported here. Further review of the recent rotator cuff repair literature on classic degenerative cuff tears is helpful to further understand the relative outcomes in patients with and without IA. In a recent study comparing mini-open cuff repair to arthroscopic cuff repair, the average ASES score at 2-year follow-up was 91 in the mini-open group and 83 in the arthroscopic group[4]. These numbers are slightly higher than we observed (77) but could be due to the shorter follow-up period within

this study. An additional study evaluating the correlations between various patient reported outcome scores following rotator cuff repair observed an average ASES of 81.2 at 2 years postoperatively, a number very similar to our study[2]. Finally, a large matched-pair analysis comparing operative and non-operative management of rotator cuff tears reported that average ASES scores at final follow-up >24 months were 81 in the operative group and 69 in the non-operative group. Our average ASES score is very comparable to that presented by this group and clearly superior to the group treated non-operatively in their study[19]. Although there is some variation, the average ASES score in our study approximates values found in other studies. This is impressive considering that patients with IA can have underlying articular pathology which could degrade ASES scores even if the rotator cuff repair remains intact.

An additional comparison between our results to outcomes following reverse shoulder arthroplasty (RSA) in IA patients is also helpful as surgeons may be inclined to move straight to arthroplasty in older patients with IA and a large or massive rotator cuff tear. In our study, 35% of patients presented with glenohumeral degenerative changes (Larson grade 2 or 3) making the decision between cuff repair and arthroplasty relevant. A previous case-series of IA patients reported a mean post-RSA ASES score of 76[10] which is very similar to the mean score of 77 we observed post-rotator cuff repair. Importantly, there is evidence that RA is associated with a higher risk of postoperative infection following primary RSA[15], in addition to literature demonstrating an increased rate of scapular spine fractures in IA patients, with a 24% prevalence observed in a RA cohort[14]. Furthermore, a recent systematic review highlighted that postoperative RSA clinical outcomes were inferior in IA patients when compared to the general population. Altogether, these results highlight that RSA for rotator cuff tears in IA patients likely

results in similar functional outcomes in comparison to rotator cuff repair but may bring with it the risk of more significant postoperative complications.

Strengths of our study include our ability to compile the largest cohort in the literature of IA patients undergoing rotator cuff repair. Additionally, we were able to use phone interviews to collect high-quality patient reported outcomes at an average follow-up of 7 years with a very high follow-up rate. The principal weakness of our study is that it is a case-series without a direct comparative group. However, rotator cuff repair in general is well studied in the literature and our outcomes can be easily compared to those presented in prior studies. Another limitation is that we are lacking certain important additional outcomes, including an assessment of healing with imaging and radiographic changes at the glenohumeral joint over time. Furthermore, we were unable to extract enough operative details to make comparisons between repair constructs which could have changed substantially during the 2008-2018 study window. Also, due to the limited size of the group and the low number of failures, we did not have statistical power to rigorously evaluate other associations of interest such as type of inflammatory arthritis, tear size, or patient age. Finally, the presumption with IA is that the inflammatory process could be affecting the glenohumeral joint and rotator cuff, however we were unable to quantify this process using inflammatory markers as has been done previously[13].

Conclusion

Rotator cuff repair in patients with rheumatoid arthritis or other inflammatory arthritis diagnoses resulted in satisfactory patient reported outcomes that are comparable to the general population. Further, re-operations were rare, with a 5-year survival rate of over 90%. Altogether, an inflammatory arthritis diagnosis by itself should not be considered a contraindication for attempted rotator cuff repair surgery in inflammatory shoulders when indicated.

References

1. Anderson K, Boothby M, Aschenbrener D, Van Holsbeeck M. Outcome and Structural Integrity after Arthroscopic Rotator Cuff Repair Using 2 Rows of Fixation: Minimum 2-Year Follow-Up. *The American Journal of Sports Medicine.* 2006;34:1899-1905. doi: 10.1177/0363546506290187

2. Assunção JH, Malavolta EA, Gracitelli MEC, Hiraga DY, da Silva FR, Ferreira Neto AA. Clinical outcomes of arthroscopic rotator cuff repair: correlation between the University of California, Los Angeles (UCLA) and American Shoulder and Elbow Surgeons (ASES) scores. *J Shoulder Elbow Surg.* 2017;26:1137-1142. doi: 10.1016/j.jse.2017.01.025

3. Austin DC, Torchia MT, Lurie JD, Jevsevar DS, Bell JE. Identifying regional characteristics influencing variation in the utilization of rotator cuff repair in the United States. *J Shoulder Elbow Surg.* 2019;28:1568-1577. doi: 10.1016/j.jse.2018.12.013

4. Barnes LA, Kim HM, Caldwell JM, Buza J, Ahmad CS, Bigliani LU, et al. Satisfaction, function and repair integrity after arthroscopic versus mini-open rotator cuff repair. *Bone Joint J.* 2017;99-b:245-249. doi: 10.1302/0301-620X.99B2.BJJ-2016-0055.R1.

5. Chen AL, Joseph TN, Zuckerman JD. Rheumatoid Arthritis of the Shoulder. *JAAOS - Journal of the American Academy of Orthopaedic Surgeons.* 2003;11:12-24. doi: 10.5435/00124635-200301000-00004

6. Fuchs B, Weishaupt D, Zanetti M, Hodler J, Gerber C. Fatty degeneration of the muscles of the rotator cuff: assessment by computed tomography versus magnetic resonance imaging. *J Shoulder Elbow Surg.* 1999;8:599-605.

7. Gabriel SE, Coyle D, Moreland LW. A Clinical and Economic Review of Disease-Modifying Antirheumatic Drugs. *PharmacoEconomics.* 2001;19:715-728.

8. Garrett WE, Jr., Swiontkowski MF, Weinstein JN, Callaghan J, Rosier RN, Berry DJ, et al. American Board of Orthopaedic Surgery Practice of the Orthopaedic Surgeon: Part-II, certification examination case mix. *The Journal of bone and joint surgery. American volume.* 2006;88:660-667. doi: 10.2106/JBJS.E.01208.

9. Goutallier D, Postel JM, Bernageau J, Lavau L, Voisin MC. Fatty muscle degeneration in cuff ruptures. Pre- and postoperative evaluation by CT scan. *Clinical orthopaedics and related research.* 1994:78-83.

10. Hattrup SJ, Sanchez-Sotelo J, Sperling JW, Cofield RH. Reverse shoulder replacement for patients with inflammatory arthritis. *J Hand Surg Am.* 2012;37:1888-1894. doi: 10.1016/j.jhsa.2012.05.015

11. Hirooka A, Wakitani S, Yoneda M, Ochi T. Shoulder destruction in rheumatoid arthritis. Classification and prognostic signs in 83 patients followed 5-23 years. *Acta orthopaedica Scandinavica.* 1996;67:258-263.

12. Jensen AR, Cha PS, Devana SK, Ishmael C, von Treuheim TDP, D'Oro A, et al. Evaluation of the Trends, Concomitant Procedures, and Complications With Open and Arthroscopic Rotator Cuff Repairs in the Medicare Population. *Orthopaedic Journal of Sports Medicine.* 2017;5:2325967117731310. doi: 10.1177/2325967117731310.

13. Lim SJ, Sun JH, Kekatpure AL, Chun JM, Jeon IH. Rotator cuff surgery in patients with rheumatoid arthritis: clinical outcome comparable to age, sex and tear size matched non-rheumatoid patients. *Annals of the Royal College of Surgeons of England.* 2017;99:579-583. doi: 10.1308/rcsann.2017.0107.

14. Miller M, Chalmers PN, Nyfeler J, Mhyre L, Wheelwright C, Konery K, et al. Rheumatoid arthritis is associated with increased symptomatic acromial and scapular spine stress fracture after reverse total shoulder arthroplasty. *JSES Int'l.* 2021;5:261-265. doi: 10.1016/j.jseint.2020.10.010

15. Nezwek TA, Dutcher L, Mascarenhas L, Woltemath A, Thirumavalavan J, Lung J, et al. Prior shoulder surgery and rheumatoid arthritis increase early risk of infection after primary reverse total shoulder arthroplasty. *JSES Int'l.* 2021;5:1062-1066. doi: 10.1016/j.jseint.2021.06.003

16. Oh JH, Kim SH, Ji HM, Jo KH, Bin SW, Gong HS. Prognostic factors affecting anatomic outcome of rotator cuff repair and correlation with functional outcome. *Arthroscopy : the journal of arthroscopic & related surgery : official publication of the Arthroscopy Association of North America and the International Arthroscopy Association.* 2009;25:30-39. doi: 10.1016/j.arthro.2008.08.010.

17. Petersson CJ. Shoulder surgery in rheumatoid arthritis. *Acta orthopaedica Scandinavica.* 1986;57:222-226.

18. Piper CC, Hughes AJ, Ma Y, Wang H, Neviaser AS. Operative versus nonoperative treatment for the management of full-thickness rotator cuff tears: a systematic review and meta-analysis. *J Shoulder Elbow Surg.* 2018;27:572-576. doi: 10.1016/j.jse.2017.09.032.

19. Ramme AJ, Robbins CB, Patel KA, Carpenter JE, Bedi A, Gagnier J, et al. Surgical Versus Nonsurgical Management of Rotator Cuff Tears: A Matched-Pair Analysis. *JBJS.* 2019;101:1775-1782. doi: 10.2106/JBJS.18.01473.

20. Reilly P, Macleod I, Macfarlane R, Windley J, Emery RJH. Dead Men and Radiologists Don't Lie: A Review of Cadaveric and Radiological Studies of Rotator Cuff Tear

Prevalence. *Annals of The Royal College of Surgeons of England.* 2006;88:116-121. doi: 10.1308/003588406X94968.

21. Sugaya H, Maeda K, Matsuki K, Moriishi J. Repair integrity and functional outcome after arthroscopic double-row rotator cuff repair. A prospective outcome study. *The Journal of bone and joint surgery. American volume.* 2007;89:953-960. doi: 10.2106/JBJS.F.00512.

22. Smith AM, Sperling JW, Cofield RH. Rotator cuff repair in patients with rheumatoid arthritis. *J Bone Joint Surg Am.* 2005;87:1782-1787. doi: 10.2106/JBJS.D.02452.

23. Tashjian RZ, Deloach J, Green A, Porucznik CA, Powell AP. Minimal clinically important differences in ASES and simple shoulder test scores after nonoperative treatment of rotator cuff disease. *J Bone Joint Surg Am.* 2010;92:296-303. doi: 10.2106/JBJS.H.01296.

24. Wu XL, Briggs L, Murrell GAC. Intraoperative Determinants of Rotator Cuff Repair Integrity: An Analysis of 500 Consecutive Repairs. *The American Journal of Sports Medicine.* 2012;40:2771-2776. doi: 10.1177/0363546512462677.

Table 1: Baseline Characteristics

Age	
Mean (SD)	60.4 (9.25)
Median	59.2
Range	38.8 - 81.2
Sex	
Female	27 (55.1%)
Male	22 (44.9%)
Body Mass Index (BMI)[#]	
Mean (SD)	31.5 (5.79)
Median	30.3
Range	20.4 - 45.3
Smoking Hx	
Never	34 (70.8%)
Former	10 (20.8%)
Current	4 (8.3%)
Diabetes Hx	
No	43 (87.8%)
Yes	6 (12.2%)
Autoimmune Diagnosis	
Rheumatoid Arthritis	24 (49.0%)
Unspecified Inflammatory Arthritis	11 (22.4%)
Psoriatic Arthritis	8 (16.3%)
SLE	5 (10.2%)
Psoriatic Arthritis and RA	1 (2.0%)
Anti-Rheumatic Medications	
Yes	40 (81.6%)
No	9 (18.4%)
Biologic Medications	
No	38 (77.6%)
Yes	11 (22.4%)
Corticosteroids	
No	32 (65.3%)
Yes	17 (34.7%)
Follow-Up Time (years)	
Mean (SD)	7.0 (2.62)
Median	6.8
Range	2.3 - 12.7

#Sample size of 43 patients. Sample size for all other outcomes was 49 patients unless otherwise specified.

Table 2: Radiographic Tear Characteristics

Hamada Classification	
1	38 (79%)
2	9 (19%)
3	1 (2%)
Larson Classification	
0	31 (65%)
1	15 (31%)
2	2 (4%)
Supraspinatus Tear	
Full Tear	40 (85%)
Partial Tear	7 (15%)
Infraspinatus Tear	
No Tear	29 (62%)
Full Tear	10 (21%)
Partial Tear	8 (17%)
Subscapularis Tear	
No Tear	24 (51%)
Full Tear	5 (11%)
Partial Tear	18 (38%)
Teres Minor Tear	
No Tear	47 (100%)
Glenohumeral Articular Change	
No	24 (51%)
Yes	23 (49%)
Number of Tendons Torn[#]	
Mean (SD)	1.8 (0.8)
Median	2
Range	1 - 3
Tear Size Sagittal (mm)[$]	
Mean (SD)	19 (12)
Median	16
Range	5 - 60
Tear Size Coronal (mm)[^]	
Mean (SD)	20 (12)
Median	17
Range	6 - 53
Tear size area (mm)[*]	
Mean (SD)	491 (584)
Median	269
Range	30 – 3,196
Fuchs Classification	
0	28 (61%)
1	16 (35%)
2	2 (4%)

#Sample size of 47 patients. $ Sample size of 45 patients. ^Sample size of 46 patients.
*Sample size of 44 patients.

Table 3. Post-Operative Outcomes (Average 7.0 years follow-up)

Pain Intensity	
Mean (SD)	2.3 (2.31)
Median	2.0
Range	0.0 - 8.0
Pain Rating	
0	18 (36.7%)
1	5 (10.2%)
2	6 (12.2%)
3	4 (8.2%)
4	6 (12.2%)
5	5 (10.2%)
6	3 (6.1%)
7	1 (2.0%)
8	1 (2.0%)
ASES Score	
Mean (SD)	77.0 (19.12)
Median	80.0
Range	35.0 - 100.0
SSV	
Mean (SD)	74.8 (21.77)
Median	85.0
Range	25.0 - 100.0
Satisfaction	
Mean (SD)	8.8 (1.92)
Median	10.0
Range	3.0 - 10.0
Satisfaction Rating	
3	1 (2.0%)
4	2 (4.1%)
5	2 (4.1%)
6	2 (4.1%)
7	2 (4.1%)
8	6 (12.2%)
9	5 (10.2%)
10	29 (59.2%)
PROMIS Upper Extremity Score[#]	
Mean (SD)	40.8 (10.58)
Median	40.5
Range	24.8 - 61.0
OTC Pain Meds	
No	40 (81.6%)

Pain Intensity	
Yes	9 (18.4%)
Prescription Pain Meds	
No	15 (30.6%)
Yes	34 (69.4%)

#Sample size of 48 patients for the PROMIS Upper Extremity score. Sample size for all other outcomes was 49 patients.