Acta Orthopaedica et Traumatologica Turcica 53 (2019) 356–359

Contents lists available at ScienceDirect

Acta Orthopaedica et Traumatologica Turcica

journal homepage: https://www.elsevier.com/locate/aott

Which patients are less likely to improve after arthroscopic rotator cuff repair?

Barak Haviv [a, b, c, *], Tal Frenkel Rutenberg [d], Lee Yaari [a, c], Muhammad Khatib [c], Ehud Rath [b], Mustafa Yassin [b, c]

[a] Arthroscopy and Sports Injuries Unit, Hasharon Hospital, Rabin Medical Center, Petach-Tikva, Israel
[b] Orthopedic Department, Sackler Faculty of Medicine, Tel-Aviv University, Israel
[c] Orthopedic Department, Hasharon Hospital, Rabin Medical Center, Petach-Tikva, Israel
[d] Orthopedic Department, Beilinson Hospital, Rabin Medical Center, Petach-Tikva, Israel

ARTICLE INFO

Article history:
Received 15 October 2018
Received in revised form
5 December 2018
Accepted 5 February 2019
Available online 8 March 2019

Keywords:
Shoulder
Rotator cuff repair
Rotator cuff tear
Supraspinatus
Factors
Predictors
Multivariable analysis
Oxford shoulder score

ABSTRACT

Objective: The aim of this study was to evaluate which specific factors influence the improvement in function and to estimate the time to obtain pain relief following arthroscopic rotator cuff repair.
Methods: A total of 97 patients (57 men and 40 women; mean age: 55.5 ± 9.3 years) who had arthroscopic rotator cuff repair between 2013 and 2016 were included into the study. Multivariable stepwise analysis included preoperative variables (age, gender, body mass index, comorbidities, occupation and participation in sports, Oxford shoulder score at baseline, preceding injury and duration of preoperative symptoms) and arthroscopic findings (size of rotator cuff tear, pathology of the long head of the biceps and cartilage lesions). The change in the Oxford shoulder score at the last follow-up was modeled as a function of the above predictor variables. The time to regain a visual analogue scale (VAS) under two points following surgery was considered the time to regain substantial pain relief.
Results: The mean follow-up time was 33.2 ± 14.4 months. Twenty three patients had partial thickness and seventy four had full thickness supraspinatus tears. In third of the patients the tears were defined as large full thickness. At the last follow-up the mean Oxford shoulder score improved from 13.8 ± 4.8 to 42.1 ± 7.2 points ($P < 0.001$). The mean VAS improved from a preoperative score of 6.7 ± 1.3 points to 1.5 ± 0.6 points postoperatively ($P < 0.001$) and 80 (83%) patients declared they were satisfied to have had the operation. The mean time interval for substantial pain relief was 4.9 ± 3.6 months. Patients with higher preoperative Oxford shoulder score and larger tear size were correlated with lesser improvement in Oxford shoulder score ($R = 0.5$, $P = 0.001$).
Conclusion: Arthroscopic rotator cuff repair improved pain and function at an average follow-up of three years. A substantial pain relief was regained within five months from surgery. Larger rotator cuff tear size and more favorable preoperative function were predictors of worse postoperative function.
Level of evidence: Level IV, Therapeutic study.
© 2019 Turkish Association of Orthopaedics and Traumatology. Publishing services by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

Introduction

Rotator cuff pathologies of the shoulder are common and evolve to full thickness tears with aging.[1–3] Arthroscopic rotator cuff repair (ARCR) is suggested whenever non operative treatment fails; however, determining which patients will do well following surgery is a challenging task and multiple factors need to be considered. Although arthroscopic rotator cuff repair is one of the most commonly performed orthopedic procedures, the evidence for decision making is still lacking.[4] Prognostic studies and systematic

The authors have no relevant financial relationships to disclose.

* Corresponding author. Arthroscopy and Sports Injuries Unit, Hasharon Hospital, Rabin Medical Center, 7 Keren Kayemet St, Petach-Tikva, 49372, Israel. Tel.: +972 3 9372750, +972 547 848145. Fax: +972 3 9372751.
E-mail address: barak_haviv69@hotmail.com (B. Haviv).

Peer review under responsibility of Turkish Association of Orthopaedics and Traumatology.

https://doi.org/10.1016/j.aott.2019.02.003
1017-995X/© 2019 Turkish Association of Orthopaedics and Traumatology. Publishing services by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

literature reviews that analyzed various potential predictors did not confirm clear independent associations between certain variables and functional outcome.[5–10] A recent systematic review has concluded that the low methodological quality and subsequently, the low quality of evidence, seriously affected the strength of recommendation.[11] The aim of this study was to determine what specific factors influence the improvement in function following arthroscopic rotator cuff repair and to estimate the time period to obtain pain relief after surgery.

Materials and methods

The study was approved by an institutional review board. Between 2013 and 2016, one hundred and forty six patients had all arthroscopic rotator cuff surgery in a department for arthroscopic procedures. The study included patients who had shoulder arthroscopy for a preoperative clinical and radiological diagnosis of rotator cuff tear with a minimal follow-up of twelve months. This study did not include patients who had labral repair procedures, acromio-clavicular joint procedures, concurrent fractures, glenohumeral joint advanced osteoarthritis or prior surgery on the same limb. Patients who had irreparable massive rotator cuff tears, patients with substantial fatty degeneration within the muscle (i.e. grade 3 or 4 according to Goutallier Classification) or who were involved in a worker compensation scheme were also excluded.

Of the 109 patients that were eligible for inclusion, 97 had consented to participate and completed follow-up (57 males, 40 females). The mean age was 55.5 ± 9.3 years (Table 1). This study was a retrospective analysis of prospectively collected data. All preoperative evaluations and operations were undertaken and reported by two senior orthopedic surgeons who specialize in arthroscopic surgery and perform similar techniques for rotator cuff repairs. Preoperative data included demographic details, detailed patient history, visual analogue scale (VAS) and the Oxford Shoulder Score (OSS) questionnaire.[12] Detailed patient history included the onset of complaints (association with trauma), duration of symptoms, occupation and participation in sports, specifically which required shoulder strain. The indication for shoulder arthroscopy in the case of diagnosed rotator cuff tear was failure of conservative treatment (i.e. activity modification, physical therapy and analgesics) or a large full thickness rotator cuff tear following shoulder trauma in patient that was previously asymptomatic. All candidates had plain radiography and magnetic resonance imaging (MRI) of the shoulder prior to surgery.

The surgery was performed in the lateral decubitus position. The glenohumeral joint was inspected, and intra-articular lesions were treated as necessary. Supraspinatus full thickness tears were first debrided and mobilized to confirm good reduction onto the footprint. If reduction was incomplete then both capsular and bursal releases were performed. The arthroscope was then removed from the joint and redirected into the subacromial space. Patients with hooked acromions or signs of frayed coraco-acromial ligament underwent acromioplasty. An assessment of tear size, configuration and degree of retraction was made. The tear was mobilized and the exposed greater tuberosity was abraded. Once the tear margins were debrided, the tendon was repaired in accordance with the tear configuration. The sagittal size of the tear was recorded and classified according to Post et al[13] Additional information included the type of repair and concomitant procedures performed. In general, patients with full thickness tears underwent a single-row repair using pre-loaded anchors with two sutures per anchor (Bio-Composite FT Suture Anchor, 5.5 mm*14.7 mm, Arthrex, Naples). The number of anchors used were one, two or three for small, medium or large full thickness tears, respectively. Patients with small articular side partial tears underwent debridement without repair. Associated pathology was addressed at the time of the index operation.

All patients were discharged from the hospital at day two after surgery with analgesics prescribed for the first two weeks and were given an instructed protocol for gradual rehabilitation. The post-operative rehabilitation program consisted of a sling support for six weeks while performing light activities, passive movements (excluding abduction) of the shoulder and mobilizing the elbow, wrist and hand. At six weeks, the patients progressed to a program of range of motion stretching exercises followed by resistive exercises at three months, supervised by a physiotherapist.

Patients were followed at two weeks, six weeks, three months and six months after surgery. Patients were also interviewed at a minimum of twelve months after the index operation to complete the Oxford Shoulder Score, visual analogue scale (VAS) and overall satisfaction from surgery.

Independent predictors for improvement

In order to predict improvement during the study period we have used the following variables as independent predictors.

Preoperative variables

Age, gender, body mass index (BMI), comorbidities (defined by the American Society of Anesthesiologists (ASA) level of physical status), occupation and participation in sports (specifically which required shoulder strain), Oxford shoulder score at baseline, preceding injury, duration of preoperative symptoms.

Arthroscopic findings

Size of rotator cuff tear, pathology of the long head of the biceps, cartilage lesions.

Statistics

Results were expressed by mean and standard deviation with an accuracy of one decimal place. Paired t test was used to compare between pre- and post-operative clinical scores. A power calculation was performed to find an adequate sample size for multivariate regression. For the given independent predictor variables and for a type I error of 0.05 with effect size of 0.2 the necessary sample size to reach a power of 0.85 was 87 observations. The correlation between different variables was calculated by the Spearman correlation coefficient. The change in the Oxford shoulder score at the last follow-up was modeled as a function of the above predictor variables with the use of multivariate stepwise regression analysis. A p-value of less than 0.05 was considered statistically significant.

Table 1
Preoperative data.

Variable	Value
N	97
Age, years	55.5 ± 9.3
Male:Female	57:40
Body mass index, kg/m^2	27.8 ± 3.9
Healthy or mild comorbidity (ASA[a]<3)	88 (91%)
Smokers	25 (26%)
Duration of symptoms, months	18 ± 7
Operated within six months	17 (18%)
Preceding injury	38 (39%)
Occupational shoulder strain	41 (42%)
Sports shoulder strain	15 (16%)

[a] ASA; American Society of Anesthesiologists level of physical status.

Results

Baseline preoperative data are provided in Table 1. The mean follow-up time was 33.2 ± 14.4 months. At the last follow-up the mean Oxford shoulder score (OSS) improved by 28.3 ± 7.1 points (95% confidence interval, 26.8–29.9, $P < 0.001$) from 13.8 ± 4.8 to 42.1 ± 7.2 points and 80 (83%) patients declared they were satisfied to have had the operation. The mean VAS improved from a preoperative score of 6.7 ± 1.3 points to 1.5 ± 0.6 points postoperatively ($P < 0.001$). A VAS score under 2 points was considered a substantial pain relief. The mean time interval to obtain substantial pain relief was 4.9 ± 3.6 months. Fourteen patients declared they did not improve at the last follow-up. Operative findings at arthroscopy are shown in Table 2. Fifty five patients had acromioplasty in addition to tendon repair. There was a significant correlation between rotator cuff tear size, age and long head of the biceps tear ($r = 0.4$, $p < 0.001$).

Multivariate stepwise regression analysis using the above preoperative variables and operative findings as independent predictors was performed for 'improvement in Oxford shoulder score (OSS)' as the dependent variable. The results showed that rotator cuff tear size and patients with higher preoperative OSS were correlated with less improvement in OSS (Table 3).

At the end of the study period three patients developed postoperative capsulitis that had resolved without additional surgery. One patient had a revision open rotator cuff repair. There were no major surgical complications such as infection, thromboembolic events or permanent nerve injuries.

Discussion

The present study showed that within a minimum of twelve months and an average of three years from arthroscopic rotator cuff repair (ARCR) there was a clinically significant improvement. Most patients achieved substantial pain relief at an average of 4.9 months; whereas larger rotator cuff tear size and patients with higher preoperative functional score were relatively correlated to worse postoperative function.

Several systematic reviews on prognostic factors influencing the outcome of ARCR were recently published. Fermont et al[7] reviewed ten selected studies and identified a total of twelve prognostic factors that were associated with better recovery. These factors were divided into four categories: demographic factors (younger age, male gender), clinical factors (higher bone mineral density, absence of diabetes, higher level of sports activity, greater preoperative shoulder motion, absence of obesity), factors related to cuff integrity (smaller sagittal size of the cuff lesion, less retraction of the cuff, less fatty infiltration, no multiple tendon involvement), and factors related to the surgical procedure (no concomitant biceps or acromioclavicular joint procedures). However, a review by Saccomanno et al[11] emphasized the low quality of evidence and stated that only baseline scores and workers compensation claim were overall accepted as important predictors of functional status.

Table 2
Surgical findings.

Variable	Value
Long head of the biceps tendon tear	28 (29%)
Chondral lesion	15 (16%)
Supraspinatus tendon tear size	
Partial	23 (24%)
Small	32 (33%)
Medium	13 (13%)
Large	29 (30%)

The published literature in a review by McElvany et al[10] showed a very high degree of variability in many of the reported clinical and anatomical key features of the patient and the shoulder. They concluded that evidence guiding surgeons and patients remained deficient and suggested that future studies include a minimum set of preoperative, treatment, and follow-up data to determine the factors associated with outcomes. For adequate analysis, the current study included a calculated sample of patients that were prospectively followed for a minimum of twelve months and a comprehensive set of preoperative and operative predictors.

Previous studies determining prognostic factors were mostly retrospective with only a few having prospective design. Fermont et al[14] have tried to identify prognostic factors having an impact on quality of life after ARCR. They followed 30 patients prospectively during the first year after surgery and found that preoperative range of motion, obesity, fatty infiltration, or retraction of the cuff as prognostic factors did not influence a successful outcome. A longer prospective follow-up of 106 patients was done by Gulotta et al.[8] They used age, tear size and other intraoperative findings as predictors. In their study there were no pre- or intraoperative factors that were predictive of an excellent functional outcome at 5 years.

Patients in the current study felt substantial pain relief at an average time of five months from surgery. Although many studies have reported restoration of shoulder function at the end of their follow-up period,[15–17] the time required for functional recovery was highlighted in only few of them. Manaka et al[18] had retrospectively evaluated 201 patients who had undergone ARCR. They assessed the functional recovery periods and preoperative influencing factors such as age, gender, shoulder stiffness, morphologic features of rotator cuff tears, and rotator cuff tear size. One hundred forty-four patients (72%) obtained functional recovery within six months after surgery. Age, shoulder stiffness, and rotator cuff tear size influenced functional recovery time. Charousset et al[19] conducted a prospective study on 114 cases of ARCR. They showed functional recovery as early as three months after surgery and further improvement over the first year, followed by stabilization. Female sex, upper-limb heavy work, poor bone quality, and lack of tendon healing were all negatively associated with outcome.

This study is one of very few studies that were intentionally designed to discover associations between different factors and less favorable clinical outcome and recovery after arthroscopic rotator cuff repair (ARCR). The study included a broad range of preoperative and operative variables that we have considered important to evaluate. Physicians can reassure candidates for ARCR beforehand that most of those variables will probably not affect the short term recovery. Conversely, patients with larger tears and higher preoperative basic function may expect worse postoperative function. The conclusions of the current study can help surgeons in their decisions making and informing patients on the expected timeline for recovery.

This study analysis may have been more powerful with larger cohort of patients; however, the number is comparable to similar studies in the orthopedic literature with the advantage of prospective follow-up and the evaluation of wide spectrum of potential outcome predictors. The study has several limitations. First this was a single rather than multi-center study with only two surgeons involved. The results of their surgical technique of single row repairs (with the exclusion of ACJ procedures) and rehabilitation protocol may not reflect the results in other centers. Second, the follow-ups were performed by the surgeons themselves and not by an independent observer which may have biased the data. Third, there were no post-operative imaging evaluations of cuff integrity; however, previous studies have shown good clinical results despite a high percentage of recurrent tears.[20] Finally, the average follow-

Table 3
Multivariate stepwise regression results.

Dependent variable	Independent variable	Coefficient	Lower 95% Confidence Interval	Upper 95% Confidence Interval	Probability	R	R^2
Improvement in OSS[a]	Supraspinatus tendon tear size	−1.9	−3	−0.8	0.001	0.5	0.3
	Preoperative OSS[a]	−0.6	−0.9	−0.3	<0.001		

[a] OSS; Oxford shoulder score.

up time was three years. It is of the authors' interest to continue and follow the patients in order to compare between short and long term outcome predictors.

In conclusion, arthroscopic rotator cuff repair improved pain and function at an average follow-up of three years. A substantial pain relief was regained within five months from surgery. Larger rotator cuff tear size and more favorable preoperative function were predictors of worse postoperative function.

References

1. Colvin AC, Egorova N, Harrison AK, Moskowitz A, Flatow EL. National trends in rotator cuff repair. *J Bone Joint Surg Am*. 2012;94(3):227–233.
2. Yamaguchi K, Ditsios K, Middleton WD, Hildebolt CF, Galatz LM, Teefey SA. The demographic and morphological features of rotator cuff disease. A comparison of asymptomatic and symptomatic shoulders. *J Bone Joint Surg Am*. 2006;88(8):1699–1704.
3. Yamamoto A, Takagishi K, Osawa T, et al. Prevalence and risk factors of a rotator cuff tear in the general population. *J Shoulder Elbow Surg*. 2010;19(1):116–120.
4. Mather 3rd RC, Koenig L, Acevedo D, et al. The societal and economic value of rotator cuff repair. *J Bone Joint Surg Am*. 2013;95(22):1993–2000.
5. Cho NS, Rhee YG. The factors affecting the clinical outcome and integrity of arthroscopically repaired rotator cuff tears of the shoulder. *Clin Orthop Surg*. 2009;1(2):96–104.
6. Chung SW, Kim JY, Kim MH, Kim SH, Oh JH. Arthroscopic repair of massive rotator cuff tears: outcome and analysis of factors associated with healing failure or poor postoperative function. *Am J Sports Med*. 2013;41(7):1674–1683.
7. Fermont AJ, Wolterbeek N, Wessel RN, Baeyens JP, de Bie RA. Prognostic factors for successful recovery after arthroscopic rotator cuff repair: a systematic literature review. *J Orthop Sports Phys Ther*. 2014;44(3):153–163.
8. Gulotta LV, Nho SJ, Dodson CC, Adler RS, Altchek DW, MacGillivray JD, HSS Arthroscopic Rotator Cuff Registry. Prospective evaluation of arthroscopic rotator cuff repairs at 5 years: part II–prognostic factors for clinical and radiographic outcomes. *J Shoulder Elbow Surg*. 2011;20(6):941–946.
9. Lambers Heerspink FO, Dorrestijn O, van Raay JJ, Diercks RL. Specific patient-related prognostic factors for rotator cuff repair: a systematic review. *J Shoulder Elbow Surg*. 2014;23(7):1073–1080.
10. McElvany MD, McGoldrick E, Gee AO, Neradilek MB, Matsen 3rd FA. Rotator cuff repair: published evidence on factors associated with repair integrity and clinical outcome. *Am J Sports Med*. 2015;43(2):491–500.
11. Saccomanno MF, Sircana G, Cazzato G, Donati F, Randelli P, Milano G. Prognostic factors influencing the outcome of rotator cuff repair: a systematic review. *Knee Surg Sports Traumatol Arthrosc*. 2016;24(12):3809–3819.
12. Dawson J, Harris KK, Doll H, Fitzpatrick R, Carr A. A comparison of the Oxford shoulder score and shoulder pain and disability index: factor structure in the context of a large randomized controlled trial. *Patient Relat Outcome Meas*. 2016;21(7):195–203.
13. Post M, Silver R, Singh M. Rotator cuff tear. Diagnosis and treatment. *Clin Orthop Relat Res*. 1983;173:78–91.
14. Fermont AJ, Wolterbeek N, Wessel RN, Baeyens JP, de Bie RA. Prognostic factors for recovery after arthroscopic rotator cuff repair: a prognostic study. *J Shoulder Elbow Surg*. 2015;24(8):1249–1256.
15. Murray Jr TF, Lajtai G, Mileski RM, Snyder SJ. Arthroscopic repair of medium to large full-thickness rotator cuff tears: outcome at 2- to 6-year follow-up. *J Shoulder Elbow Surg*. 2002;11(1):19–24.
16. Wilson F, Hinov V, Adams G. Arthroscopic repair of full-thickness tears of the rotator cuff: 2- to 14-year follow-up. *Arthroscopy*. 2002;18(2):136–144.
17. Wolf EM, Pennington WT, Agrawal V. Arthroscopic rotator cuff repair: 4- to 10-year results. *Arthroscopy*. 2004;20(1):5–12.
18. Manaka T, Ito Y, Matsumoto I, Takaoka K, Nakamura H. Functional recovery period after arthroscopic rotator cuff repair: is it predictable before surgery? *Clin Orthop Relat Res*. 2011;469(6):1660–1666.
19. Charousset C, Grimberg J, Duranthon LD, Bellaïche L, Petrover D, Kalra K. The time for functional recovery after arthroscopic rotator cuff repair: correlation with tendon healing controlled by computed tomography arthrography. *Arthroscopy*. 2008;24(1):25–33.
20. Russell RD, Knight JR, Mulligan E, Khazzam MS. Structural integrity after rotator cuff repair does not correlate with patient function and pain: a meta-analysis. *J Bone Joint Surg Am*. 2014;96(4):265–271.