



Risk factors for symptomatic retears after arthroscopic repair of full-thickness rotator cuff tears

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Background: Factors affecting a rotator cuff symptomatic retear after arthroscopic repair have yet to be clearly identified, since they usually influence the surgical decisions.

Methods: Consecutive patients with full-thickness tear of the supraspinatus who underwent arthroscopic repair were retrospectively analyzed. Cases of symptomatic retear, defined as Sugaya type IV and V on magnetic resonance imaging, associated with intensive pain and/or functional impairment were identified at follow-up. The patients with no symptomatic retear were selected as the control group. Information from potential risk factors of symptomatic retear, including depression and subacromial corticosteroid injections, was extracted from the medical records. The statistical analysis included multivariate logistic regression.

Results: The symptomatic retear rate was 9.5% in 158 patients. Patients in the symptomatic retear group were more likely to be smoking, to have massive tears, a short acromiohumeral distance, and moderate to severe fatty infiltration. They also had had more frequently subacromial corticosteroid injections and depression. However, following the multiple logistic regression analysis, only massive tears and moderate to severe fatty infiltration remained significantly associated. Similarly, in relation to the study hypothesis, both corticosteroid injections (odds ratio [OR] 6.66, 95% confidence interval [CI] 1.49, 29.81; $P = .013$) and depression (OR 8.26, IC 1.04, 65.62; $P = .046$) were significantly associated with symptomatic retear risk.

Conclusions: This study found support for the hypothesis that both depression and corticosteroid infiltration before surgery are independent risk factors for symptomatic retear after arthroscopic repair of rotator cuff.

Level of evidence: Level III; Retrospective Cohort Comparison; Treatment Study

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The study has been performed in accordance with the ethical standards in the 1964 Declaration of Helsinki, and the hospital ethical committee approved the study, to conform with Spanish law: Ethical Committee for Clinical Research in the CEIC idesalud in Cataluña (Internal Code [study number]: 2016/49-COT-ASEPEYO).

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Retears after rotator cuff repair have been documented in numerous studies,^{20,21,29} but the wide discrepancies in the reported rates may indicate different definition criteria used.^{3,23,33,39} Specifically, some studies that have reported high re-tear rates included cases whose diagnoses were based on magnetic resonance imaging (MRI) findings but had no symptoms such as pain and functional impairment.⁷ However, those re-tears with clinical symptoms (symptomatic re-tears) have particular interest because they usually influence the surgical decisions. Moreover, in view of the different surgical alternatives,³² surgical decisions would be facilitated by information on risk factors of symptomatic re-tears, because this improves the clinical utility.

Many factors have been implicated in rotator cuff re-tear,^{10,30,34} but abundant between-study discrepancies are also present^{9,29,33} and result in the general view that the factors affecting a rotator cuff re-tear are yet to be clearly identified. In fact, on the basis of a literature search, a recent systematic review concluded that it was not possible to reach any definitive conclusion regarding the most relevant predictors of outcome of rotator cuff repair.⁴¹ Furthermore, the previous studies have generally been conducted in heterogeneous samples with a high proportion of elderly patients. It is therefore important to identify factors that predict “symptomatic re-tears,” after arthroscopic repair of the rotator cuff in a sample of younger, working-age patients.

Interestingly, 2 potential risk factors for re-tears, which were not included in prior studies, may merit special consideration in view of insufficient and contradictory available information. The first one is related to corticosteroid infiltrations. There is considerable evidence of the association of corticosteroid use and tendon rupture risk,^{17,26,44} but only a few studies have approached this association in relation specifically to rotator cuff re-tears. Bjorkenheim et al⁵ reported a failed end result in two-thirds of the patients who received more than 3 preoperative local steroid injections, and the increased rotator cuff revision rates have more recently been reported in some studies.^{43,45} However, the study by Baverel et al³ concluded that “preoperative CSIs had no influence on re-tear rates.”

The second potential risk factor of special interest refers to depression. Perruccio et al,⁴⁰ and more recently Christino et al,¹¹ have underlined the relevance of studying mental well-being and psychosocial factors in relation to the outcome of surgery in this field. Specifically, depression has been associated with a negative outcome of several orthopedic disorders,^{14,25,46} but the available evidence is scarce and controversial in relation to rotator cuff repair. Kennedy et al²⁸ found in their review that most studies support that psychosocial factors, including depression, are associated with negative outcomes of the surgery, but some showed significant improvements in postoperative pain and function. A relevant study by Cho et al⁸ suggested that depression has an impact on clinical outcome, but the same

authors have more recently reported that depression did not influence the clinical course during the first postoperative year.⁹

The purpose of this study is to try to confirm, in working-age patients, that factors reported in prior studies increase the risk of symptomatic re-tears after arthroscopic rotator cuff repair and test specifically the hypothesis that both depression and corticosteroid infiltration are independent risk factors.

Material and methods

Patient selection

A retrospective review in the hospital database of general data prospectively collected for this study identified all consecutive patients who underwent arthroscopic rotator cuff tear (RCT) repair in the institution from January 2008 through December 2010, when a suitable form of computerized registration began operating.

Inclusion and exclusion criteria

Among the patients who underwent arthroscopic RCT repair, only patients with full-thickness tear of the supraspinatus with or without a combined tear of other rotator cuff tendon were included. The patients with isolated subscapularis injury, margin convergence rotator cuff repair, associated calcifying tendonitis, and patients who underwent revision repair surgery were all excluded.

A total of 185 patients with rotator cuff tear were operated within the recruitment period. Following the inclusion and exclusion process, 158 of them were selected for the study. The reasons for exclusion were isolated subscapularis injury (6 cases), margin convergence rotator cuff repair (7 cases), associated calcifying tendonitis (4 cases), irreparable rotator cuff tear (2 cases) and previous revision repair surgery (8 cases). The mean age of the patients included was 52.3 ± 6.8 years (range 31-63), and men predominated in this sample ($n=109$; 69%).

Indications for surgery and description of techniques

Initially, patients with shoulder pain and functional impairment were advised to start a conservative treatment: limitation of physical activity, even immobilization, and oral, anti-inflammatory drugs. If the functional impairment persisted after 2-3 weeks, a rehabilitation treatment was recommended. A sub-acromial bursa steroid injection was required in some cases because of the intensity of pain. Rotator cuff repair was indicated when the conservative treatment did not result in improvement after 3 months. The surgery was in all cases preceded by MRI examinations. All images were reported by a radiologist specialized on musculoskeletal disorders, but 2 independent, experienced shoulder surgeons reviewed the images to reach a consensus. Inter- or intraobserver reliability were not calculated. Some cases required an intraoperative decision to proceed with arthroscopic repair or alternative procedures.

All patients were operated under general anesthesia and interscalene block. They were positioned in lateral decubitus with 30° of abduction of the upper extremity and under 4-5 kg of traction. Rotator cuff tear was confirmed within the procedure after subacromial bursa excision. Most full-thickness RCTs smaller than 1 cm were repaired by single row, using traditional double-row and suture bridge/transosseous equivalent for 1-cm or larger tears. During the operation, some cases were considered to be irreparable and were therefore excluded. All operations were performed by the same team of shoulder specialists, using the same surgical criteria for rotator cuff repair.

For rehabilitation (RHB), the same procedure was followed in all cases: abduction pillow immobilization was applied immediately and for 3 weeks after surgery, and pendulum exercises and passive motion were started in the fourth week. Active assisted motion with pulley was performed, starting in the sixth week, increasing the active range of motion in the seventh to eighth week. Strengthening exercises were not allowed before 10-12 weeks.

Postoperative MRI was performed when the clinical evaluation was unsatisfactory (persistent pain and/or weakness), and/or when retears were suspected, particularly after the strength exercise was initiated. A total of 25 postoperative MRIs were obtained in a mean time of 8.3 ± 3.5 months.

Study criteria: symptomatic retears

Cases with full-thickness symptomatic re-tear after repair were identified and selected during the follow-up period. Symptomatic re-tear was defined as Sugaya type IV and V on MRI,⁴² associated with intensive pain (visual analog scale score ≥ 5) and/or functional impairment (positive Jobe test and/or external rotation lag sign²⁴). All patients included in the study who underwent the RCT repair, but had no symptomatic re-tear, were selected as the control group.

Risk factors considered

Information from the following potential risk factors of symptomatic re-tear of the repaired tendon was extracted from the medical records: age and sex; body mass index; diabetes mellitus (DM); cardiovascular disease (CVD); smoking; demanding work (manual work usually requiring the upper extremities); previous RHB (preoperative RHB completed); symptom duration before surgery (months); injured LHB and/or subscapularis (SSC) tendon; tenotomy/tenodesis in the LHB; SSC tendon surgical repair (procedure completed); massive tear (>5 cm or involving 2 or more tendons); surgery time (minutes); and repair technique (single row, double row, or suture bridge).

Other potential risk factors analyzed include the acromio-humeral distance (AHD), which was measured from the inferior surface of the acromion to the superior aspect of the humeral head, and was dichotomized into patients with or without AHD less than 7 mm (AHD < 7 mm); and the degree of fatty infiltration, which was classified according to the Goutallier stages,²² and was dichotomized into patients with Goutallier 3 or 4 fatty infiltration and those with Goutallier 0-2 changes.

Corticosteroid injection (CSI) use was considered when the patient received 1 or more preoperative injections and depression when the patient had a medical diagnosis of depression at the time

of the surgical assessment and/or was receiving antidepressant treatment because of depression. The patients were not assessed with specific instruments. This information was determined by retrospective review of the medical records, which includes all visits to the patient's family doctor.

Statistical methods

Continuous variables were described using means and standard deviations. Categorical variables were tabulated with absolute and relative frequencies. First, a bivariate analysis was performed to compare technical and clinical factors between symptomatic re-tear and control groups. Pearson chi-squared test was used for categorical variables and Fisher correction as appropriate if frequencies in any group were less than 5. Continuous variables were analyzed by the Student *t* test. Kolmogorov-Smirnov test was applied to identify absence of normal distribution of continuous variables, using Mann-Whitney *U* test for the analysis.

Then, a multivariate logistic regression analysis was performed to study the association of all potential predictive factors with symptomatic retears. Symptomatic re-tear was the dependent variable, and all variables with significant differences between groups in the bivariate analysis were included as independent ones. Age and sex were also included as potential confounders.

Throughout the statistical analysis, $P < .05$ values were considered to be statistically significant. Statistical analyses were conducted using IBM SPSS Statistics, version 20.0 (IBM, Armonk, NY, USA), and RStudio, version 0.99.896 (RStudio, Boston, MA, USA).

Results

Fifteen of the 158 patients selected for the study (9.5%) were identified as suffering symptomatic rotator-cuff re-tear (symptomatic re-tear group). The remaining 143 cases with uneventful postoperative courses comprised the control group. Five patients who had symptoms showed healed cuffs on MRI.

The mean follow-up time was 42.2 ± 10.6 months, and mean time from surgery to symptomatic re-tear diagnosis was 7.9 ± 3.7 months.

Table I displays demographic and clinical characteristics of symptomatic re-tear cases and the no-symptomatic re-tear, control group. No between-group, significant differences by age or sex were observed in the univariate analysis. Similarly, no differences were observed in relation to having a demanding job/work or in parameters such as symptom duration, surgery time, or type of surgical technique, medical history (DM or CVD), or tendons injured (LHB, SSC). On the contrary, significant differences between the patients in the symptomatic re-tear group and the controls were observed in different variables. Specifically, in relation to the hypothesis, patients in the re-tear group had had more frequently CSIs and a medical diagnosis of depression and/or were taking antidepressants.

Table I Differences in demographic characteristics and in potential risk factors between patients with and without symptomatic rotator cuff re-tear

	Symptomatic re-tear (n=15)	No symptomatic re-tear (n=143)	<i>P</i> value*
Age, yr, mean \pm SD (range)	52.5 \pm 7.2 (41-63)	52.3 \pm 6.8 (31-63)	.9
Male sex	8 (53.3)	101 (70.6)	.168
Diabetes mellitus	1 (6.7)	11 (7.7)	>.99
Cardiovascular disease	3 (20)	21 (14.7)	.7
Depression	6 (40)	6 (4.2)	<.01
Tobacco	11 (73.3)	61 (42.7)	.03
Demanding work	13 (86.7)	117 (81.8)	>.99
Previous RHB	11 (73.3)	103 (72)	>.99
Corticosteroid injection	9 (60)	21 (14.7)	<.01
Symptom duration, mo mean \pm SD	10.7 \pm 5.4	8.7 \pm 6.4	.09
Surgery time, min mean \pm SD	81 \pm 9.7	85.2 \pm 15.3	.3
LHB tenotomy/tenodesis	8 (53.3)	55 (38.5)	.263
SSC tendon injured	3 (20)	33 (23.1)	>.99
SSC tendon repair	1 (6.7)	20 (14)	.69
Massive tear	12 (80)	54 (37.8)	.002
AHD <7 mm	8 (53.3)	7 (46.7)	.011
Moderate to severe fatty infiltration	13 (86.7)	47 (32.9)	<.01
Repair technique:			.08
Single row	0 (0)	33 (23.1)	
Double row	8 (53.3)	48 (33.6)	
Suture bridge	7 (46.7)	62 (43.4)	

RHB, rehabilitation; LHB, long head of the biceps; SSC, subscapularis; AHD, acromiohumeral distance.

Unless otherwise indicated, data are n (%). Bolded *P* values indicate statistically significant difference between groups.

* χ^2 test for categorical data and the Mann-Whitney *U* test for continuous data.

The results of the logistic regression analysis are shown in Table II. In the univariate analysis, smoking, massive tear, AHD <7 mm, and moderate to severe fatty infiltration, as well as depression and CSI were all associated with symptomatic re-tear risk. However, the results of the multiple logistic regression analysis show that the associations between smoking or AHD and symptomatic re-tear were no longer significant. On the contrary, they remained significant for both massive tears and moderate to severe fatty infiltration. Similarly, in relation to the study hypothesis, both CSI (odds ratio [OR] 6.66, 95% confidence interval [CI] 1.49, 29.81; *P* = .013) and depression (OR 8.26, 95% CI 1.04, 65.62; *P* = .046) were significantly associated with symptomatic re-tear risk.

Discussion

The symptomatic re-tear rate in this study was 9.5%. Similar, low rates have been reported in some studies,^{34,47} but wide discrepancies are observed in the literature, and some surgeons report very high rates (41%³⁷; 45.5%⁴⁸). However, the higher rates come from studies incorporating individuals with large lesions and older than in this study³⁷ or from studies including re-tears diagnosed on the basis of image findings.³⁸ On the contrary, only symptomatic re-tears were included in this study, which are

particularly relevant because they are considered to be the ones that usually influence the surgeons' decisions.

The most important findings of the present study support the hypothesis that both depression and corticosteroid injections are independent risk factors for symptomatic re-tear after arthroscopic rotator cuff repair. In view of the paucity of studies addressing these factors, the findings may have special relevance. In the present study, the use of 1 or more CSIs was associated with more than a 6-fold increase in the risk of symptomatic re-tears. Different studies have described the potential benefits of corticosteroids before surgical repair, such as to prevent the need for surgical intervention, alleviating pain, and facilitating rehabilitation, or to prepare shoulders preoperatively, decreasing inflammation in the subacromial bursa.³ However, concerns about potential risks have also been raised, such as the excitotoxic tendon damage,¹³ and Bjorkenheim et al⁵ reported "a failed result" in two-thirds of those patients receiving more than 3 preoperative local steroid injections. Similarly, the studies by Traven et al⁴³ and by Weber et al⁴⁵ have shown that preoperative shoulder injections, particularly if they are close to the time of surgery, increase the risk of revision rates. Although, in a more recent and relevant study, Baverel et al³ concluded that "preoperative CSIs had no influence on clinical scores and re-tear rates" and suggested that their findings "may resolve controversies about the administration of preoperative CSIs," their conclusions

Table II Association of potential risk factors and symptomatic rotator cuff retears (multiple logistic regression analysis)

	Univariate		Multivariate	
	OR (95% CI)	<i>P</i> value	OR (95% CI)	<i>P</i> value
Age	1.01 (0.93, 1.09)	.9	0.94 (0.84, 1.06)	.303
Sex	2.1 (0.72, 6.17)	.168	2.98 (0.48, 18.52)	.240
Depression	14.54 (3.66, 57.71)	<.01	8.26 (1.04, 65.62)	.046
Tobacco	4.29 (1.27, 14.6)	.03	1.96 (0.39, 9.65)	.407
Corticosteroid injection	9.88 (3.06, 31.95)	<.01	6.66 (1.49, 29.81)	.013
Massive tear	8.68 (2.19, 34.44)	.002	7.59 (1.24, 46.39)	.028
AHD <7 mm	4.38 (1.42, 13.51)	.011	1.49 (0.29, 7.68)	.634
Moderate to severe fatty infiltration	14.05 (2.92, 67.6)	<.01	7.72 (1.29, 46.33)	.025

AHD, acromiohumeral distance; OR, odds ratio; CI, confidence interval.
 Bolded *P* values indicate statistical significance.

cannot be considered definitive in view of the present results and the studies reviewed. Baverel et al have underlined the importance of an adequate injection technique to avoid the potential adverse events, but the discrepant results in this study cannot be attributed to a deficient technique, which was performed by experienced surgeons. On the contrary, the differences with these authors might be due to the severity of the injurers in the patients in the present study, because close to half had “massive lesions” and, contrary to Baverel et al, who had only 4% of their cases with stage 3 fatty infiltration, the present study had 22.2% of cases in stage 3 plus 15.8% in stage 4.

Depression in this study was associated with more than 8-fold increase in the risk of symptomatic retears, after controlling for a considerable number of factors reported to be of risk in different studies. It is remarkable that the subject of psychopathologic aspects did not attract much attention in this field until recently, as suggested by Peruccio et al.⁴⁰ Depression has recently been considered a predictor of poor outcome in different orthopedic disorders.^{14,25,46} In relation specifically to rotator cuff repair, the available evidence is scarce. Cho et al⁸ reported that 26.2% of patients scheduled for rotator cuff repair had depression, which was a strong predictor of self-assessed functional disability in preoperative measurements, but contrary to their expectations, preoperative depression did not predict poor outcome after rotator cuff repair.⁹ It is also difficult to compare the studies of Cho et al and this study. They assessed the patients with the Hospital Anxiety and Depression Scale,⁴⁹ a self-report screening instrument of proved consistency and reliability, which has been frequently used for the detection of depression in medical patients, including patients with musculoskeletal disorders. High scores in this instrument indicate greater likelihood of depression. However, the use of self-report instruments is limited by their rather low predictive value for clinically significant, treatable depression.^{12,36} In relation to this, the effect sizes in the association of depression with medical conditions has been shown to be larger when full diagnosis rather than self-report questionnaires were used to assess depression.¹ Although the patients in this study were not

assessed with specific instruments, the clinicians considered that the patients had depression and/or had evidence that they were on antidepressant treatment. The advantage of having information on clinically significant, treatable depression is that eventually it would be important to test to what extent successfully treating the depression prevents the development of symptomatic retear.

The present study has also supported a number of previous reports documenting the association of both massive tears^{18,48} and moderate to severe fatty infiltration and retear risk.^{16,29,35,37} Some authors relate the fatty infiltration to molecular mechanisms of tendon-bone healing, such as recombinant human bone morphogenetic protein-12 and matrix metalloproteinases.^{4,31} Kim et al could not confirm the association with fatty infiltration, but offered a possible reason because they excluded in their sample some severe cases with a high probability of retears.²⁹

On the contrary, this study has not found support for the potential of smoking as a risk factor of symptomatic retear. There is generalized concern in the discipline about the negative influence of smoking, because of its negative effect in the wound-healing process in relation to the synthesis of subcutaneous collagen²⁷ or in the chronic inflammation and decreased cell proliferation.¹⁹ Moreover, some previous reports found an association of smoking and tear risk,⁶ although a recent review found no effect on any structural outcome and only on functional outcome.⁴¹ However, one important difference with studies suggesting a positive association of smoking with retear risk is that depression was controlled in the present study. Smoking has been shown to be an important risk factor of depression.¹⁵

Similarly, this study has not found support for several elements previously reported to increase the risk of retears, including patient age, sex, having a demanding job/work, symptom duration; BMI, DM, or CVD; previous RHB, injured LHB and/or SSC tendon, tenotomy/tenodesis in the LHB, AHD <7 mm, SSC tendon surgical repair; and surgery time or repair technique. Nevertheless, it is difficult to compare this study with previous reports in view of important sampling and/or methodologic differences. For example, the

patients in this sample were in general younger than in most previous studies, and probably in relation to this, the prevalence of DM and/or CVD was much lower in this sample.^{10,29} In any case, a relevant systematic review has concluded that, related to methodologic questions and questions of design, “it was not possible to reach any definitive conclusion regarding the most relevant predictors of outcome of rotator cuff repair.”⁴¹ The findings reported here may stimulate additional studies of the effect of corticosteroid injections and of the effect of treating depression to decrease the risk of symptomatic retears.

Among the strengths of this study is the sample, which contrary to most previous studies is limited to working-age patients, and emphasizes the potential risk associated with both corticosteroid injections and depression and controls for an important number of previously reported potential risk factors. Among the limitations, it might be argued that sample size is limited in view of the number of variables analyzed. Although this size fulfills common recommendations for regression analysis,² power analysis was not calculated and the possibility of type 2 error cannot be discarded. The retrospective determination of steroid injection and depression may contribute to inaccuracies, although the information on the medical records is considered to be reliable. Furthermore, spurious correlation in a retrospective study cannot be discarded. Finally, the influence of some factors uncontrolled in this study cannot be discarded.

Conclusion

This retrospective study has found support for the hypothesis that both depression and corticosteroid infiltration before surgery, which were infrequently studied until recently, are independent risk factors for symptomatic retear after arthroscopic repair of rotator cuff. Moreover, support has also been found for some, but not all, studies documenting the risk associated with massive tears and fatty infiltration.

Disclaimer

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