



# Does a subscapularis tear combined with a posterosuperior rotator cuff tear affect postoperative functional outcomes?

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**Background:** The subscapularis is biomechanically important for the shoulder. However, few studies have clinically assessed its importance using a comparative design. Our objective was to compare the functional outcomes in patients who underwent isolated repair of posterosuperior rotator cuff tears and those with repair of combined tears involving the subscapularis.

**Methods:** We performed a retrospective cohort study evaluating patients who underwent arthroscopic full-thickness rotator cuff repair between January 2013 and May 2017. The patients were divided into 2 groups: isolated repair of posterosuperior tears and repair of combined tears involving the subscapularis. The primary outcome was to evaluate the American Shoulder and Elbow Surgeons (ASES) and University of California, Los Angeles (UCLA) scales at 24 months' follow-up.

**Result:** A total of 326 patients were evaluated: 194 with isolated posterosuperior repairs and 132 with combined subscapularis repairs. Both groups showed significant improvement with the procedure ( $P < .001$ ). The ASES score at 24 months showed no significant difference ( $P = .426$ ) between the group without subscapularis repair (median, 90.0; interquartile range [IQR], 24.8) and the group with subscapularis repair (median, 86.3; IQR, 33.2). Similarly, the UCLA score showed no difference between the groups (median, 33.0 [IQR, 6.0] and 32.5 [IQR, 8.8], respectively;  $P = .190$ ). The preoperative functional evaluation also showed no significant differences between the groups.

**Conclusion:** The functional results did not differ between patients who underwent isolated repair of posterosuperior tears and those with repair of combined tears involving the subscapularis, according to the ASES and UCLA scales at 24 months.

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

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**Keywords:** Rotator cuff tear; rotator cuff repair; arthroscopy; subscapularis muscle; subscapularis tear; functional and structural outcomes

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Rotator cuff disease is the leading cause of consultations with shoulder specialists,<sup>14</sup> and 20% of the population is affected by tears of these tendons at some point in the individuals' lives.<sup>23</sup> Despite being the strongest rotator cuff muscle, the subscapularis has long been neglected in the medical literature and has been called the "forgotten tendon."<sup>12</sup>

This tendon is important in balancing the shoulder forces,<sup>12</sup> and damage to it affects the joint biomechanics.<sup>24</sup>

Only 1% of rotator cuff tears affect only the subscapularis,<sup>6,7</sup> whereas more than half of patients with posterosuperior tears present with combined subscapularis tears.<sup>5,13</sup> Subscapularis repair, whether in isolation<sup>8,10</sup> or in association with the repair of posterosuperior tears,<sup>2</sup> leads to significant clinical improvement. However, the majority of studies on the subject are case series, and there have been few comparative studies on the clinical importance of subscapularis repair.<sup>11,16,18</sup>

Monroe et al<sup>16</sup> evaluated a cohort of patients with subscapularis tears, comparing the postoperative results of patients with isolated tears of this tendon with those of patients who had combined posterosuperior tears. Park et al<sup>18</sup> and Lee et al,<sup>11</sup> meanwhile, compared the results of isolated posterosuperior repairs with associated subscapularis repairs in patients with massive rotator cuff tears. These 3 articles showed no functional differences between the study groups. To our knowledge, no study to date has compared the clinical outcomes of isolated posterosuperior repairs with combined subscapularis repairs in a population not restricted to massive rotator cuff tears.

The aim of this study was to compare the functional outcomes between patients who underwent repair of isolated posterosuperior tears and those with repair of combined tears involving the subscapularis.

## Methods

### Study design

This retrospective cohort study compared the functional results of rotator cuff repair between 2 groups of patients: those with isolated posterosuperior tears and those with combined subscapularis tears. We considered posterosuperior tears as those that affected the supraspinatus tendon, whether or not these were associated with the infraspinatus. We included patients with procedures performed between January 2013 and May 2017 by 4 different surgeons.

### Eligibility criteria

This study included patients who underwent arthroscopic full-thickness rotator cuff repair and preoperative magnetic resonance imaging (MRI), without the use of intra-articular contrast, on a  $\geq 1.5$ -T device. We excluded patients with isolated subscapularis tears, rotator cuff arthropathy, inflammatory arthropathy, moderate or severe glenohumeral arthrosis according to the Samilson and Prieto classification,<sup>21</sup> or previous shoulder surgery; those in whom complete repair was not possible; and those not submitted to preoperative or postoperative functional evaluation.

### Outcome

The primary outcome was to evaluate the American Shoulder and Elbow Surgeons (ASES)<sup>19</sup> and University of California, Los

Angeles (UCLA)<sup>3</sup> scales at 24 months' follow-up. The clinical scores were assessed by an independent evaluator (not an author). The secondary outcome was to identify factors related to the presence of a subscapularis tear and its relationship with the characteristics of posterosuperior rotator cuff tears.

## Variables analyzed

Variables related to the patients comprised age, sex, whether the dominant side was affected, smoking, diabetes, previous injection, and previous trauma of the affected shoulder. Variables related to the tear consisted of the thickness of the supraspinatus tear (partial or full thickness), retraction of the supraspinatus tear ( $< 30$  mm or  $\geq 30$  mm), infraspinatus tear (present or absent), and degree of fatty degeneration of the rotator cuff musculature (subscapularis, supraspinatus, and infraspinatus), according to Fuchs et al.<sup>4</sup> Variables related to the procedure included acromioplasty, distal clavicular resection, or procedures involving the long head of the biceps (no, yes, or not applicable). Tenotomy and tenodesis were considered procedures. Cases with previous full-thickness tears of the long head of the biceps were categorized as "not applicable." Finally, variables related to the subscapularis (only in the subscapularis repair group) comprised the tear pattern (partial articular, full thickness of upper third, or full thickness of upper two-thirds or entire tendon) and the number of anchors used for the repair.

All variables related to the tear, with the exception of fatty degeneration, were determined by arthroscopic inspection. The clinical evaluation by the ASES<sup>9,19</sup> and UCLA<sup>3,17</sup> scales was conducted 1 week before the surgical procedure and 24 months afterward.

## Magnetic resonance imaging

MRI examinations were performed using a 1.5-T magnet (Signa HDxT; General Electric Medical Systems, Waukesha, WI, USA) with a dedicated shoulder coil. The acquisition protocol for the shoulder included oblique coronal proton density-weighted images (repetition time [TR], 2800 milliseconds; echo time [TE], 38 milliseconds; field of view [FOV], 14 cm; slice thickness, 3.5 mm; spacing, 0.4 mm; matrix, 320  $\times$  256); axial, oblique coronal, and oblique sagittal T2-weighted images with fat saturation (TR, 3400 milliseconds; TE, 50 milliseconds; FOV, 14 cm; slice thickness, 3.5 mm; spacing, 0.4 mm; matrix, 256  $\times$  256); and oblique sagittal T1-weighted images (TR, 780 milliseconds; TE, 15 milliseconds; FOV, 14 cm; slice thickness, 3.5 mm; spacing, 0.4 mm; matrix, 320  $\times$  256). No intra-articular or intravenous paramagnetic contrast (gadolinium) was used. The images were analyzed by musculoskeletal radiologists with between 5 and 18 years of experience.

## Arthroscopy

All procedures were performed with the patient under general anesthesia associated with an interscalene block. The patient was positioned in the beach-chair or lateral decubitus position, depending on the surgeon's preference, and the conventional portals were used. With the 30° scope positioned in the posterior portal, the appearance of the subscapularis tendon was examined using the lever-push maneuver<sup>1</sup> in all cases. Through the anterior and anterolateral portals, the tendinous insertion was palpated,

using a probe when necessary. The other variables described earlier were inspected in a standardized manner.

The tendon of the long head of the biceps was approached when it presented subluxation or dislocation; partial tears >50%; or type 2, 3, or 4 tears of the superior labrum. The procedure performed was tenotomy in patients aged  $\geq 60$  years or tenodesis in younger patients. Tenodesis, when indicated, was performed with one of the anchor sutures used to repair the rotator cuff or with an additional anchor positioned in the bicipital groove.

The subscapularis tendon was repaired in partial tears >5 mm and full-thickness tears. Tears <5 mm did not undergo any approach. The repair of both posterosuperior and subscapularis tears was performed by a technique using a single row of anchors and doubly loaded high-resistance implants. The procedures were performed by 4 shoulder surgeons with 10 to 12 years of experience.

## Rehabilitation

The shoulder was immobilized for 6 weeks. No motion was permitted during the first 3 weeks; passive exercise was permitted thereafter. Active-assisted and active-free exercises were started after week 6, when sling use was discontinued. Muscle strengthening was started at week 12.

## Statistical analysis

We tested the continuous variables for the assessment of normality using the Kolmogorov-Smirnov test and assessment of homogeneity through the Levene test. Categorical variables were expressed as absolute values and percentages. Continuous variables were expressed as means and standard deviations when they presented a parametric distribution and, additionally, as medians and interquartile ranges (IQRs) when they showed a nonparametric distribution. The baseline data of the sample were compared between groups by the  $\chi^2$  test (for categorical variables) or the Student *t* test (for continuous variables).

A multiple regression analysis, including all variables that showed a statistically significant difference between the groups at baseline, was performed. Secondary analysis was performed with the analysis-of-variance test and evaluated the influence of the subscapularis tear pattern (no tear, tear < 5 mm, partial tear > 5 mm, full-thickness tear of upper one-third, or full-thickness tear affecting upper two-thirds or more), the procedure performed on the long head of the biceps (none, tenotomy, or tenodesis), and the presence of an infraspinatus tear on the postoperative results.

The preoperative vs. postoperative comparison in each group, according to the ASES and UCLA scales, was performed using the Wilcoxon test. The comparison between the functional results before surgery and those at 24 months, in accordance with whether subscapularis tendon repair was performed, was conducted using the Mann-Whitney test. For data analysis, we used the SPSS software program (version 21.0; IBM, Armonk, NY, USA), with a level of significance of 5%.

## Results

In the period studied, we performed 399 arthroscopies for the treatment of rotator cuff tears. We excluded from the

analysis patients in whom only débridement (10), isolated subscapularis repair (5), reoperation (3), or partial rotator cuff repair (34) was performed, as well as those without preoperative clinical information (21). The sample analyzed consisted of 326 shoulders (308 patients).

The variables related to the patients demonstrated that the subscapularis repair group was older ( $P < .001$ ), with no difference in the other factors analyzed (Table I). The variables related to the tear showed that the subscapularis repair group presented greater retraction of the supraspinatus tear ( $P < .001$ ), a higher rate of infraspinatus tears ( $P = .003$ ), and higher degrees of fatty degeneration of the supraspinatus ( $P = .003$ ) and subscapularis ( $P = .028$ ). The variables related to the procedure, meanwhile, showed that the subscapularis repair group was more frequently submitted to acromioplasty ( $P = .011$ ) and procedures performed on the long head of the biceps ( $P < .001$ ). The data can be seen in Table II. A multiple regression analysis showed that the factors that differed between the groups did not influence the clinical results (Table III). The secondary analyses did not show any influence of the subscapularis tear pattern (ASES score,  $P = .859$ ; UCLA score,  $P = .839$ ), procedures performed on the long head of the biceps (ASES score,  $P = .400$ ; UCLA score,  $P = .125$ ), or the presence of an infraspinatus tear (ASES score,  $P = .830$ ; UCLA score,  $P = .716$ ) on the final results.

The specific characteristics of the subscapularis repair group are described in Table IV. We observed that the

**Table I** Variables related to patients

	Subscapularis repair		<i>P</i> value
	No (n = 194)	Yes (n = 132)	
Age, mean $\pm$ SD	54.6 $\pm$ 8.7	58.3 $\pm$ 8.4	<.001
Sex, n (%)			.178
Male	78 (40.2)	63 (47.7)	
Female	116 (59.8)	69 (52.3)	
Dominant side affected, n (%)			.950
Yes	139 (71.6)	95 (72.0)	
No	55 (28.4)	37 (28.0)	
Smoking, n (%)			.652
Smoker	27 (13.9)	16 (12.1)	
Former smoker	31 (16.0)	26 (19.7)	
No	136 (70.1)	90 (68.2)	
Diabetes, n (%)			.293
Yes	23 (11.9)	21 (15.9)	
No	171 (88.1)	111 (84.1)	
Previous injection, n (%)			.935
Yes	33 (17.0)	22 (16.7)	
No	161 (83.0)	110 (83.3)	
Traumatic tear, n (%)			.261
Yes	16 (8.2)	16 (12.1)	
No	178 (91.8)	116 (87.9)	

SD, standard deviation.

**Table II** Variables related to tear and procedure

	Subscapularis repair		P value
	No (n = 194)	Yes (n = 132)	
Supraspinatus tear			
Partial thickness	28 (14.4)	10 (7.6)	.058
Full thickness	166 (85.6)	122 (92.4)	
Retraction of supraspinatus			
<30 mm	160 (82.5)	84 (63.6)	<.001
≥30 mm	34 (17.5)	48 (36.4)	
Infraspinatus tear			
Yes	31 (16.0)	39 (29.5)	.003
No	163 (84.0)	93 (70.5)	
Fuchs classification of supraspinatus			
Grade I	170 (87.6)	97 (73.5)	.003
Grade II	21 (10.8)	27 (20.5)	
Grade III	3 (1.5)	8 (6.1)	
Fuchs classification of infraspinatus			
Grade I	169 (87.1)	109 (82.6)	.226
Grade II	18 (9.3)	20 (15.2)	
Grade III	7 (3.6)	3 (2.3)	
Fuchs classification of subscapularis			
Grade I	186 (95.9)	118 (89.4)	.028
Grade II	8 (4.1)	11 (8.3)	
Grade III	0 (0.0)	3 (2.3)	
Acromioplasty			
Yes	161 (83.0)	94 (71.2)	.011
No	33 (17.0)	38 (28.8)	
Distal clavicular resection			
Yes	6 (3.1)	1 (0.8)	.153
No	188 (96.9)	131 (99.2)	
Procedure on long head of biceps			
None	114 (58.8)	19 (14.4)	<.001
Tenotomy or tenodesis	75 (38.7)	99 (75.0)	
Not applicable (auto-tenotomized)	5 (2.6)	14 (10.6)	

**Table III** Multiple regression analysis for control of confounding factors

	Coefficient	95% CI		P value
		Inferior	Superior	
Age	0.109	-0.290	0.577	.077
Fuchs classification of supraspinatus	-0.280	-4.816	3.331	.720
Fuchs classification of subscapularis	-0.930	-7.203	1.335	.177
Retraction of supraspinatus	-0.450	-9.484	5.243	.571
Supraspinatus tear (partial vs. full thickness)	0.530	-4.292	1.104	.385
Procedure on long head of biceps	0.260	-2.101	3.213	.681
Acromioplasty	0.330	-4.756	8.093	.610
Infraspinatus tear	0.500	-4.506	9.573	.479

CI, confidence interval.

majority of the repairs were performed in patients with tears restricted to the upper third of the tendon, by use of a single anchor.

Both groups showed significant improvement with the procedure based on the 2 scales analyzed ( $P < .001$ ). The

ASES score at 24 months showed no statistically significant difference ( $P = .426$ ) between the group without subscapularis repair (median, 90.0; IQR, 24.8) and the group with subscapularis repair (median, 86.3; IQR, 33.2). Likewise, the UCLA score did not differ between the groups

**Table IV** Characteristics of subscapularis tear and repair

	Subscapularis repair (n = 132)	
	n	%
Type of tear		
Partial articular	55	41.7
Full thickness of upper one-third	56	42.4
Full thickness of upper two-thirds or entire tendon	21	15.9
No. of anchors		
1	115	87.1
2	17	12.9

(median, 33.0 [IQR, 6.0] vs. 32.5 [IQR, 8.8];  $P = .190$ ). The groups also did not differ significantly in the preoperative functional evaluation (Table V).

## Discussion

Our results demonstrate that the clinical evaluation performed at the end of 24 months of follow-up did not show any statistically significant differences between patients who underwent repair of isolated posterosuperior rotator cuff tears and those with combined subscapularis repairs. Patients with isolated posterosuperior tears showed a median ASES score of 90.0 and median UCLA score of 33.0. Meanwhile, patients with combined subscapularis repair showed medians of 86.3 and 32.5, respectively.

The findings of this study call for some interpretations. Although the group with combined subscapularis tears presented poorer structural characteristics, the functional evaluations were similar even in the preoperative period. A possible explanation for this is the lack of sensitivity of the scales used, which were not able to detect differences even when the tendon integrity was known to differ between the groups. The absence of postoperative functional differences at 24 months was to be expected, as the groups both started with similar functional conditions. Another relevant point is

that 84% of subscapularis tears evaluated in this study were partial articular or full-thickness tears of the upper third of the tendon, which may limit their biomechanical and functional importance.

The lack of difference that we observed is in agreement with the findings of other comparative studies evaluating different patterns of rotator cuff tears. Monroe et al<sup>16</sup> analyzed a cohort of 145 patients, divided into those with isolated subscapularis tears and those with combined tears. The clinical outcome, after a minimum follow-up of 24 months, was a score of approximately 50 on the PROMIS-UE (Patient-Reported Outcomes Measurement Information System–Upper Extremities) scale for the different groups, without a statistically significant difference. Park et al<sup>18</sup> studied 92 patients with massive rotator cuff tears. All patients presented with posterosuperior tears; the study groups were formed according to the appearance of the subscapularis: intact, involvement of the upper half, or involvement of more than half of the tendon. The results were slightly poorer in patients with an intact subscapularis, although without a statistically significant difference. The values found according to the ASES scale ranged from 78.8 (untorn subscapularis in patients with pseudoparalysis) up to 87.5 (torn subscapularis in patients without pseudoparalysis). Lee et al<sup>11</sup> studied 122 patients with massive rotator cuff tears, all also presenting with posterosuperior tears. The study groups were formed according to the appearance of the subscapularis: intact, tear affecting the upper third, and tear affecting more than the upper third. The authors also found no statistical difference between the groups, with values on the ASES scale ranging from 85.7 (intact subscapularis) to 81.7 (tear in upper third). Our clinical outcomes are slightly higher than those of the aforementioned authors, probably because we included smaller tears in our sample. It is worth noting that both our study and the other studies<sup>11,16,18</sup> were performed with the single-row technique, but the technique used to repair the posterosuperior tear varied between the single- and double-row techniques.

Our study, similarly to that of Monroe et al,<sup>16</sup> did not perform structural analysis of the repairs. Lee et al<sup>11</sup>

**Table V** ASES and UCLA scores according to subscapularis repair

	Subscapularis repair								P value
	No (n = 194)				Yes (n = 132)				
	Mean	SD	Median	IQR	Mean	SD	Median	IQR	
ASES score									
Preoperative	42.9	18.2	42.8	26.7	42.1	21.2	38.3	31.1	.533
24 mo	83.5	18.6	90.0	24.8	79.0	23.3	86.3	33.2	.426
UCLA score									
Preoperative	15.0	4.9	14.0	7.0	14.5	4.9	14.0	7.0	.285
24 mo	30.9	5.3	33.0	6.0	29.5	6.7	32.5	8.8	.190

ASES, American Shoulder and Elbow Surgeons; UCLA, University of California, Los Angeles; SD, standard deviation; IQR, interquartile range.



observed a 31% rate of retears in general in their analysis by MRI, these being more frequent in the group with the most severe subscapularis tears. Subscapularis retears were also more frequent in this group. Park et al,<sup>18</sup> using ultrasound assessment, found a 27% rate of retears in general and 18% rate of retears for subscapularis tears, with all of them occurring in the group with more severe subscapularis tears. Patients with subscapularis retears showed poorer clinical outcomes.

Our study has some limitations. First, it was a retrospective cohort study, with the biases inherent to this type of design. Moreover, we did not evaluate the structural results after the surgical procedure. However, it is known that the functional results did not show any clinically significant differences between patients with and patients without structural integrity.<sup>20</sup> Studies in the same line of research found similar results to ours (ie, no difference between patients with and without repair of the subscapularis)<sup>11,18</sup> and a similar rate of retears to that reported by the largest systematic review on the subject.<sup>15</sup> Moreover, despite using widely disseminated functional scales, we did not evaluate specific tests in the physical examination to determine the strength of each of the rotator cuff tendons individually. The UCLA and ASES scales, similarly to the vast majority of functional evaluation tools, consider only anterior flexion strength or elevation and not internal rotation. Our sample is more heterogeneous than the samples of other authors, who limited their analyses to patients with massive tears,<sup>11,18</sup> but this only serves to increase the external validity of the data. However, we added a multiple regression analysis to reduce the bias that may arise from this heterogeneity, including all variables that showed a statistically significant difference between the groups. The regression analysis demonstrated that the confounding factors did not significantly affect the clinical results. In addition, we performed secondary analyses evaluating the influence of the subscapularis tear pattern, the procedure performed on the long head of the biceps, or the presence of an infraspinatus tear on the postoperative results, which also did not demonstrate statistically significant findings. The single-row repair can be a reason for criticism. This option was selected because of economic limitations and the limited availability of orthopedic implants in our institution, common in several developing countries. However, the technique was used in all cases, regardless of the group studied, which reduces the possibility of bias. In addition, clinical results have not yet shown superiority with the double-row technique.<sup>22</sup>

Regarding favorable points, our study had a larger sample size than the sample sizes of other similar studies.<sup>11,16,18</sup> In addition, the postoperative clinical evaluation was performed in a standardized way at 24 months, not at variable times, as in other studies.<sup>11,16,18</sup> This serves to decrease measurement bias. We emphasize that we repair all tears affecting more than 5 mm from the insertion of the

subscapularis. Our data do not allow us to compare the results between repair and non-repair of small subscapular tears, as we believe that those >5 mm should always be repaired. Neither do they allow us to determine whether partial tears of a smaller size benefit from surgical treatment.

Finally, although our results, similarly to those of other authors,<sup>11,18</sup> did not demonstrate any statistically significant differences between cases with and cases without repair of the subscapularis, we believe this tendon is of great biomechanical importance. In our view, the main reason for this lack of difference may be a bias of measurement, with the functional scales not being sensitive enough to assess the function of the subscapularis. Future studies, with prospective designs and larger samples, and new forms of evaluation, with items that evaluate strength and daily activities that depend on the subscapularis tendon, may help us to better understand the importance of this once "forgotten" tendon.<sup>12</sup>

## Conclusion

The functional results did not differ between patients undergoing isolated repair of posterosuperior tears and those with repair of combined tears involving the subscapularis, according to the ASES and UCLA scales at 24 months.

## Disclaimer

The authors, their immediate families, and any research foundations 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.

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