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Can subcoracoid cyst formation be a sign of anterosuperior rotator cuff tears and biceps pulley lesions? A prospective radiologic and arthroscopic correlation study

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Background: The aim of this study was to investigate the pathologies associated with subcoracoid cysts (ScCs) in patients with rotator cuff (RC) tears and the postoperative appearance of ScCs after arthroscopic repair.
Methods: A total of 114 patients who underwent arthroscopic RC repair were prospectively evaluated. The inclusion criteria were as follows: patients with or without ScCs, patients with Patte class 1 or 2 tears, and patients who were 40-65 years of age. Forty-four patients with ScCs (group 1) were evaluated during the 12-month study period. Fifty-two patients who had no ScCs (group 2) were evaluated as a control group. Preoperative and postoperative cyst volumes were measured on magnetic resonance imaging (MRI), and arthroscopic findings were noted.
Results: Thirty-one patients (70%) in group 1 had a subscapularis tear vs. 10 patients (19%) in group 2 ($P < .001$). Biceps lesions were encountered in 32 patients (72%) in group 1, whereas 12 patients (23%) had a biceps lesion in group 2 ($P < .001$). Cyst volume was significantly higher in the following situations: (1) patients who had a subscapularis tear compared with patients without a subscapularis tear, (2) patients who had biceps pulley lesions compared with patients without pulley lesions, and (3) patients who had both pathologies ($P = .047$, $P = .01$, and $P = .002$, respectively). Cyst volumes significantly decreased following RC repair in group 1 ($P < .001$).
Conclusion: Among patients with small- to medium-sized, full-thickness supraspinatus tears, the prevalence of biceps pulley lesions and/or subscapularis tears is higher in patients with ScCs.
Level of evidence: Level III; Cross-Sectional Design; Epidemiology Study

Keywords: Subcoracoid cyst; rotator cuff; biceps pulley lesion; radiology; arthroscopy

This study was approved by the ethics committee of the University of Health Sciences, Umraniye Training and Research Hospital (13.04.2017 no: BD8389745262).

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The subcoracoid bursa (ScB) is located between the anterior region of the subscapularis muscle, the conjoined tendon of the coracobrachialis, and the short head of the biceps.[10] The prevalence of ScB was reported as 0.7% of patients in magnetic resonance imaging (MRI) studies and 27.7% in magnetic resonance arthrograms.[7,9,12] The ScB is not associated with the glenohumeral joint but may be continuous with the subacromial-subdeltoid bursae.[20] Subcoracoid effusion, which is the accumulation of fluid in the ScB, is usually observed in pathologic conditions such as rotator cuff (RC) tears, subcoracoid impingement, and adhesive capsulitis.[5,7,17] Numerous studies have reported an association between superior RC tears and subcoracoid cysts (ScCs), whereas a limited number of studies revealed a coincidence between rotator interval lesions and ScCs.[7,12,22]

The biceps pulley is a capsuloligamentous structure that helps to stabilize the biceps tendon in the bicipital groove. It consists of the superior glenohumeral ligament, the coracohumeral ligament, and the distal attachment of the subscapularis tendon and is located within the rotator interval.[14] Rotator interval lesions commonly occur because of tears of the subscapularis tendon and the anterior border of the supraspinatus tendon.[10] Rotator interval lesions are also associated with pathologies of the long head of the biceps (LHB) tendon and secondary internal shoulder impingement.[3] The ScB is important because it is located close to the aforementioned structures, and the relationship between ScCs and rotator interval lesions still needs to be addressed.

In this prospective study, the associations among ScCs, subscapularis tendon tears, and biceps pulley lesions were evaluated in patients who underwent an RC repair. We hypothesize that ScCs may be associated with biceps pulley lesions and/or subscapularis tendon tears. In addition, we hypothesize that postoperative cyst size may decrease after arthroscopic RC repair.

Materials and methods

All procedures performed in this study that involved human participants were performed in accordance with the ethical standards of the institutional and national research committees and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. This article does not contain any studies involving animals that were performed by any of the authors. Informed consent was obtained from all the individuals in this study.

Between April 2017 and May 2018, a total of 114 consecutive patients from a single institution who were scheduled to undergo arthroscopic RC repair were prospectively evaluated. The surgical indication criteria were the presence of a chronic RC tear for which nonoperative treatment methods, such as pain medication and physical therapy, failed after 6-8 months. The inclusion criteria for the study were as follows: patients with or without ScCs, patients with class 1 or 2 coronal plane tears according to the Patte classification,[18] patients who underwent arthroscopic RC repair, and patients who were 40-65 years of age.

Patients with pathologies likely to mimic ScC formation were determined. Three patients with a positive subcoracoid impingement test, 3 patients with autoimmune disease, 4 patients with inflammatory arthritis, and 8 patients who had subacromial or intra-articular injections during the preoperative period were excluded from the study.

Of the 114 patients, 18 met 1 or more of the exclusion criteria, and the remaining 96 patients were available for the study. Forty-four patients with ScCs (group 1) were prospectively evaluated during the 12-month study period. Fifty-two patients who had no ScCs (group 2) met the inclusion criteria and were evaluated as a control group.

The age, sex, and operation date of the patients were recorded. Constant scores[4] during the preoperative and 12th-month postoperative follow-up of the patients were recorded by a third physician who was blinded to the surgical approach.

Surgical technique and postoperative period

All patients were operated under general anesthesia with standard anterior, posterior, anterolateral, and posterolateral portals. In addition to routine glenohumeral joint examination, internal-external rotation of the arm was performed at 90° abduction, and biceps pulley and subscapularis tendon lesions were recorded. Subscapularis tendon tears were determined according to the Lafosse classification by arthroscopic visualization.[11] The coronal topographic extent of the RC tears was classified according to the Patte classification.[18] The presence of biceps lesions was determined according to the Habermayer classification.[8] All subscapularis ruptures were Lafosse type 1 and 2 lesions and repaired using 2 sutures and one 3.5-mm knotless anchor (Smith & Nephew, Andover, MA, USA). Biceps tenotomy was performed in patients who had a biceps pulley lesion or other pathology of the LHB tendon. RC tears were repaired with a double-row technique using 5- or 6.5-mm metallic and knotless anchors (Smith & Nephew). After the operation, a standard rehabilitation program was applied to all patients. Pendulum, passive elevation, and external rotation exercises were started on the first postoperative day. In the fourth week, the arm sling was removed, and stretching exercises were used to increase the range of motion; strengthening exercises started at 8 weeks. These exercises were recommended as standard exercises in a home exercise program. Rehabilitation of the patients was continued for 6 months.

Radiologic evaluation and classification

Shoulders were evaluated with an Optima MR450w with GEM Suite 1.5-tesla MRI spectrometer (General Electric Medical Systems LLC, Waukesha, WI, USA) using an HD 8-channel shoulder array by NeoCoil. The arm was fixed to the patient's body in the anatomic position. The reference lines were placed parallel to the clavicle with the glenoid at a right angle (field of view, 20.0; slice thickness, 4.0 mm; and spacing, 1.0 mm).

All patients were evaluated via noncontrast study-specific acquisition MRI preoperatively, and the patients who had ScCs received an additional MRI at the 12th-month follow-up (Figs. 1-4). In the 12th-month postoperative MRI, the cyst volumes were compared with those from the preoperative MRI.

During MRI evaluation, cyst volume measurements were performed by a radiologist and an experienced musculoskeletal

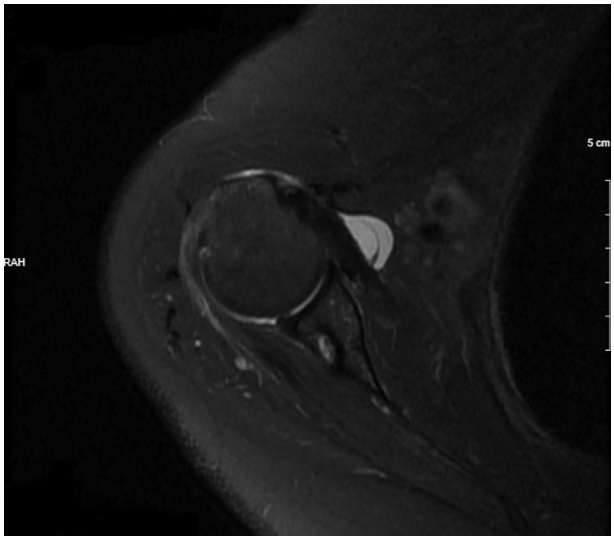

Figure 1 Preoperative magnetic resonance image of a patient with subcoracoid cyst formation.

surgeon in a blinded manner using OSiriX MD (Pixmeo, Bernex, Switzerland). In the MRIs, the cross-sectional areas of the cyst were determined by manually drawing the outer border of the cyst with a ''closed polygon technique'' on each axial section of the bursa at the T2 sequence. The most proximal part of the bursa was noted as C_1 (mm^2), and the most distal part was noted as C_n (mm^2). The distance between each section was calculated to be 4 mm. The total cyst volume was calculated by using the modified Cavalieri method: $(C_1 + C_2 + \cdots + C_n) \times 4 =$ total bursae volume (mm^3).[15] The measurements obtained by the 2 specialists were subjected to interobserver testing. The averages of the 2 specialists' measurements were taken into account. The data gathered from the 2 examiners were distributed.

Statistical analysis

The sample size calculation was performed using G*Power 3 (Heinrich Heine Universitat, Dusseldorf, Germany). Based on our calculations, a minimum sample size of 41 patients was required to observe a difference between the preoperative and postoperative ScC volume values (type I error [α] of 0.05, power [$1 - \beta$] of 0.80).

Statistical analyses were performed using the Statistical Package for Social Sciences for Windows, version 21.0 (IBM Corp., Armonk, NY, USA). In the comparisons of the groups, the nonparametric Mann-Whitney *U* test was used. Spearman rank correlation test was used to calculate the correlations between specific variables. The Fisher exact test was used to determine differences between categorical variables or between relationships. *P* values less than .05 were considered statistically significant. The *r* value was used to determine the magnitude of the relationship between 2 variables.

Results

All patients had a supraspinatus tear and underwent arthroscopic repair. The mean age of the patients was 54.2 $\pm$ 8.63 years in group 1 and 54.1 $\pm$ 6.6 years in group 2.

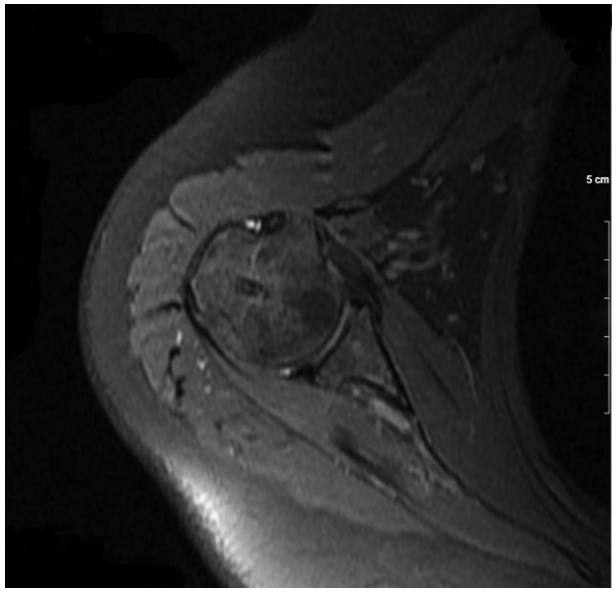

Figure 2 Postoperative magnetic resonance image of the same patient showing a decrease in subcoracoid cyst volume.

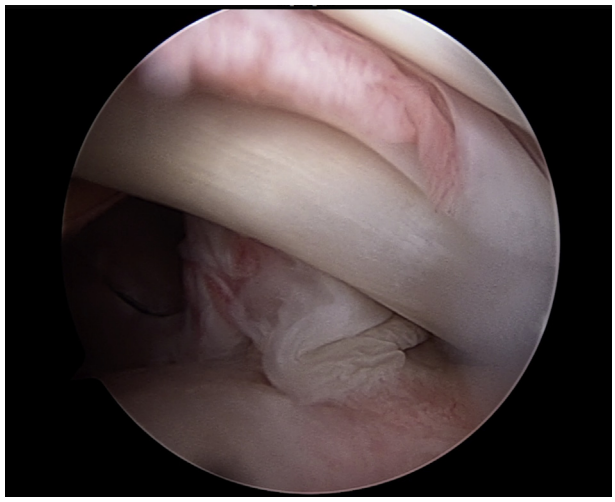

Figure 3 Arthroscopic findings of the patient demonstrate an anterior biceps pulley lesion (right shoulder biceps tendon view from a posterior portal).

Thirty-one patients (70%) in group 1 had a subscapularis tear vs. 10 patients (19%) in group 2 ($P < .001$). Biceps lesions were encountered in 32 patients (72%) in group 1, whereas 12 patients (23%) had a biceps lesion in group 2 ($P < .001$). No difference was found between the 2 groups in terms of age, sex, or distribution of Patte coronal class RC tears. Detailed data are presented in Table I.

The intraclass correlation coefficient (ICC) between the 2 examiners was found to be 0.91, indicating high interclass reliability of the gathered measurements. Cyst volume was significantly higher in the following situations: (1) patients who had a subscapularis tear compared with patients without a subscapularis tear, (2) patients who had biceps

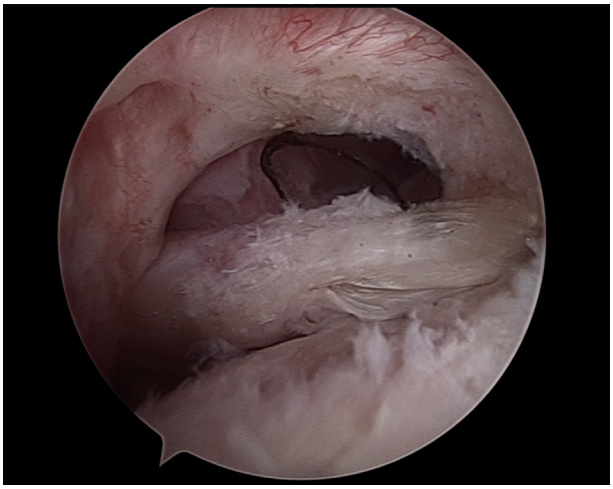

Figure 4 Arthroscopic visualization of the patient demonstrates a tear in the upper third of the subscapularis tendon.

pulley lesions compared with patients without pulley lesions, and (3) patients who had both pathologies ($P = .047$, $P = .01$, and $P = .002$, respectively) (Table II).

In the MRI results, preoperative cyst volumes significantly decreased following RC repair in group 1 ($P < .001$). Postoperative Constant scores were significantly higher than preoperative scores ($P < .001$) (Table II). However, no significant correlation was found between cyst volume and Constant scores at the preoperative and the final follow-up ($r = 0.09$, $P = .5$; $r = –0.1$, $P = .4$, respectively).

Table I Demographic variables and radiologic and arthroscopic findings

	Group 1, n (%)	Group 2, n (%)	*P* value
Sex			
Female	27 (61)	33 (63)	.83*
Male	17 (39)	19 (37)	
Subscapularis tear (Lafosse classification)			
Yes	31 (71)	10 (20)	<.001*
Type 1	21	5	
Type 2	10	5	
No	13 (29)	42 (80)	
Biceps pulley lesion (Habermayer classification)			
Yes	32 (73)	12 (23)	<.001*
Type 1	2	0	
Type 2	1	1	
Type 3	21	8	
Type 4	8	1	
No	12 (27)	40 (77)	
Rotator cuff tear (Patte coronal classification)			
Type 1	31 (71)	29 (56)	.2*
Type 2	13 (29)	23 (44)	
Age, yr, mean ± SD	54.2 ± 8.63	54.1 ± 6.6	.32†

SD, standard deviation.
* Fisher exact test.
† Mann-Whitney *U* test.

Discussion

The main finding of this study is that patients with supraspinatus tears and ScCs may have a biceps pulley lesion or a subscapularis tendon tear. In addition, our results show that ScCs regress significantly in patients after RC repair.

Effusion in the ScB with RC tears was first described by Schraner et al,[20] and the authors reported that 5 of 11 patients had an ScC with an RC tear. Grainger et al[7] determined that all patients with ScB effusion had evidence of RC tears. In addition, the authors reported that 11 of 16 patients had rotator interval tears, 1 patient had a tear of the LHB tendon, and no patient had a subscapularis tear.[7] In another radiologic study, 11 of 23 patients had large subcoracoid effusions with an RC tear.[12] Although these studies reported an association of RC tears on MRI with small patient size, a control group, and an arthroscopic correlation were lacking. In our cohort, all patients also had RC tears with ScCs. In addition to the previous studies, our results showed that the prevalence of subscapularis tendon tears and biceps pulley lesions was also significantly higher in patients with an ScC than in those without an ScC. Despite their small cohort, Tung et al[22] also reported a significant relationship between subcoracoid effusion and tears of both the supraspinatus and subscapularis tendons. In contrast to previous studies, we also assessed the relationship between cyst size and associated pathologies. Cyst volume was significantly higher in the presence of a subscapularis tear and/or biceps pulley lesion. This raises the question of why ScCs occur, and several explanations can be proposed according to our findings. ScCs may occur as a result of an inflammatory response after trauma or may be related to impingement resulting from an RC tear.[7] In addition, the existence of subscapularis tears and biceps pulley lesions (injuries of the rotator interval) may also cause fluid accumulation in the ScB due to a disruption of the rotator interval, which may lead to fluid extravasation from the glenohumeral joint or subacromial bursa.

Our findings indicate that when an ScC is seen on MRI, a careful review of RC tears, including subscapularis tendon tears and biceps pulley lesions, is required during the arthroscopic examination. Most subscapularis tears

Table II Comparison of variables in group 1

	Mean ± SD	Median (min-max)	*P* value*
Sc cyst volume, mm^3			<.001
Preoperative	1067.24 ± 1840.13	0 (0-6749.38)	
Postoperative	288.6 ± 652.64	0 (0-3522.6)	
Constant score			<.001
Preoperative	29.36 ± 6.5	28 (18-42)	
Postoperative	79.25 ± 14.24	78 (43-98)	
Patte coronal class, preoperative Sc cyst volume, mm^3			.29
1	1018.6 ± 1909.9	0 (0-6749.4)	
2	1183.1 ± 1730.3	785.6 (0-6468)	
Biceps pulley lesion, preoperative Sc cyst volume, mm^3			.047
Yes	1188.4 ± 2061.4	644.7 (0-6749.4)	
No	210.8 ± 401.5	0 (0-1013.1)	
Subscapularis tear, preoperative Sc cyst volume, mm^3			.01
Yes	1449.4 ± 2069.9	785.6 (0-6749.4)	
No	155.9 ± 380.5	0 (0-1013.1)	
Biceps pulley lesion + subscapularis tear, preoperative Sc cyst volume, mm^3			.002
Yes	1931.7 ± 2211.4	1570.7 (0-6749.4)	
No	63.0 ± 178.1	0 (0-503.9)	

Sc, subcoracoid.
* Mann-Whitney *U* test.

have been reported to occur on the articular and superior aspect of the footprint; therefore, an arthroscopic assessment of the subscapularis tendon has been suggested for the definitive diagnosis of subscapularis tears.[1,6,19] Foad et al[6] determined that subscapularis tendon tears are frequently missed on MRI. Numerous studies reported that 18%-62.5% of patients with arthroscopy-confirmed subscapularis tears were misdiagnosed on preoperative MRI.[1,6,13,22] Moreover, tears of the subscapularis tendon may be missed even during shoulder arthroscopy if they are not being specifically looked for.[19] Similar to subscapularis tendon tears, previous studies demonstrated the poor sensitivity of MRI for the assessment of LHB lesions.[2,16,21] We believe that recognition of ScCs and their associated pathologies may improve the efficiency of diagnosis for missed pathologies on MRI and during surgery.

The clinical significance of ScBs has not yet been clarified. Neither a specific examination method nor a surgical technique has been described for these bursal structures that are incidentally encountered on many shoulder MRIs. No study has investigated whether ScCs still exist following RC repair or impact clinical scores. Our study showed that preoperative cyst volumes significantly decreased 12 months following RC repair; however, no significant relationship was found between cyst volume and Constant scores at the final follow-up. This result may support our explanation, because no fluid extravasation or impingement is expected following an RC repair.

The present study had certain limitations. Although the number of patients was statistically sufficient, the sample size was relatively small. A follow-up period longer than 12 months could be more reliable in terms of monitoring cyst recurrence. In addition, an MRI investigation could have been performed in the control group to reveal a possible relationship between ScCs and RC integrity following RC repair. Despite the aforementioned limitations, this is the first study and the study with the largest sample size in the literature to correlate the arthroscopic and radiologic findings related to ScCs and accompanying shoulder pathologies using a control group.

Conclusion

Among patients with small- to medium-sized, full-thickness supraspinatus tears, the prevalence of biceps pulley lesions and/or subscapularis tears is increased in patients with ScCs.

Disclaimer

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