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Original Article

Diagnostic Value of Magnetic Resonance Imaging Based Coracoid Morphology in Patients with Subscapularis Tears

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ABSTRACT

Background: This study investigates the association between subscapularis tendon tears and the anatomical characteristics of the coracoid process, as assessed by magnetic resonance imaging (MRI) and to determine the predictive cut-off values for significant measurements.
Methods: Patients who underwent surgery for rotator cuff injury between 2020 and 2024 were retrospectively reviewed. Those with a subscapularis tear were classified as Group 1, while those with an intact subscapularis were classified as Group 2. MRI images were analyzed to measure axial and sagittal coracohumeral distance (axCHD, sagCHD), coracoid overlap (CO), and coracoid angle (CA). The diagnostic utility of these parameters was assessed using receiver operating characteristic (ROC) curve analysis.
Results: A significant association was found between subscapularis tear and axCHD, sagCHD, and CO measurements. Among these, sagCHD demonstrated the strongest predictive power, with an optimal threshold of 9.5 mm, a sensitivity of 77.8% and a specificity of 80.4%.
Conclusion: Our study demonstrated that decreased axCHD and sagCHD, and increased CO, are associated with subscapularis tears. The intracoracoid angle, however, does not appear to influence the incidence of subscapularis tears.

Keywords: Coracoid, Human and medicine, Rotator cuff injuries, Subscapularis

INTRODUCTION

The subscapularis muscle, the most voluminous and strongest component of the rotator cuff, plays a critical role in shoulder biomechanics. It primarily facilitates internal rotation of the humerus and contributes significantly to the stabilization of the glenohumeral joint.[1,2] Subscapularis tendon tears account for approximately 4–13% of all rotator cuff injuries detected in arthroscopic or imaging studies. Although less prevalent than supraspinatus or infraspinatus tears, isolated or combined subscapularis tears can lead to substantial deficits in shoulder function, including anterior shoulder pain, internal rotation weakness, and increased risk of anterior instability.[3,4]

Subscapularis tears may occur in isolation or as part of a more extensive rotator cuff injury, often resulting from trauma, repetitive microtrauma, or degenerative changes. The advent of high-resolution magnetic resonance imaging (MRI) and MR arthrography has significantly enhanced the diagnostic accuracy for subscapularis pathology, with reported sensitivities ranging from 71% to 91% and specificities up to 95%.[5,6]

An important factor in patients with subscapularis tears is the role of coracoid morphology and its potential contribution to subcoracoid impingement.[7] Anatomical variations in the coracoid process, such as decreased coracohumeral distance or abnormal angulation, have been suggested to predispose individuals to mechanical impingement of the subscapularis tendon, leading to or exacerbating tears.[8] Understanding this relationship has provided new insight into the etiology and management of subscapularis injuries.

This study aims to examine the impact of coracoid morphology and subcoracoid impingement on subscapularis tears.

METHODS

Ethical Approval

This retrospective study was initiated with the approval of the U.H.S Istanbul Training and Research Hospital Clinical Research Ethics Committee (Decision No. 176), dated July 11, 2025.

Patient Selection

Patients who underwent surgery for rotator cuff injury between 2020 and 2024 were identified using the hospital database. Patient information was retrieved by searching for the National Healthcare Implementation Communique codes 612900, 612910, and 613260 (open or arthroscopic rotator cuff repair/debridement).

Inclusion and Exclusion Criteria

A total of 205 patients were evaluated according to the exclusion criteria, and 161 patients were included in the study.

Exclusion criteria: traumatic rotator cuff tears (high-energy shoulder trauma within 6 months), concomitant shoulder instability lesions (Bankart/Hill-Sachs lesion in MRI or intraoperative finding), history of septic arthritis of the shoulder (positive joint culture or typical sequelae on MRI), shoulder osteoarthritis (according to Samilson-Prieto classification)[10], any previous ipsilateral shoulder surgery, glenoid deformity (significant bony defect on MRI), tumors or rheumatologic diseases (documented history of relevant systemic/local pathology).

Patient Grouping

Patients with a subscapularis tear were classified as Group I, while those with an intact subscapularis were classified as Group II.

Subscapularis tears were classified intraoperatively according to the Lafosse classification.[9]

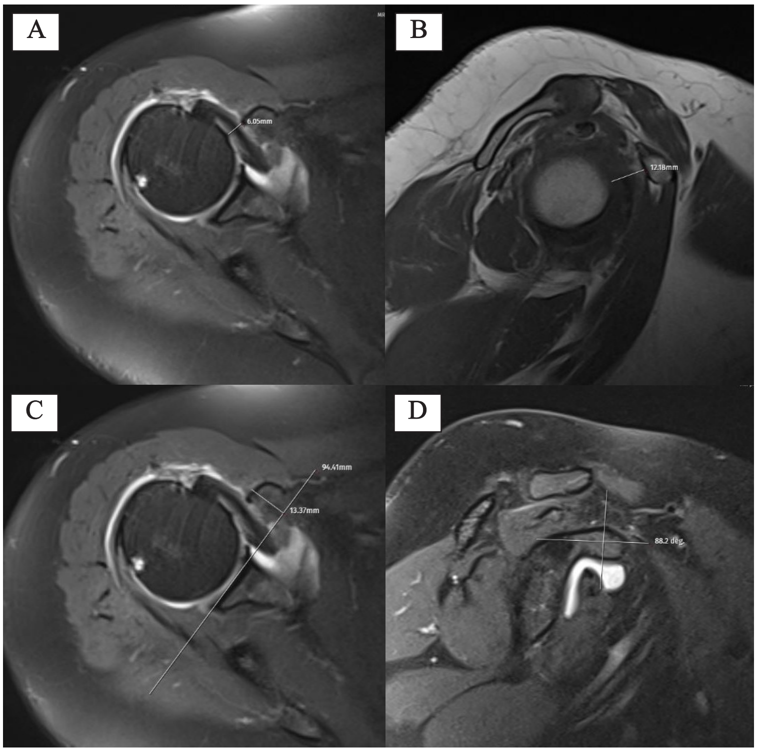

Figure 1. Coracoid-related measurements (A) axial coracohumeral distance (axCHD), (B) sagittal coracohumeral distance (sagCHD), (C) coracoid overlap (CO), (D) intracoracoid angle (CA).

MRI Evaluation and Measurements

All MRI scans performed using 1.5 T scanners from the same manufacturer (Siemens, Magnetom, Germany) in three planes: axial, oblique coronal, and oblique sagittal. Axial coracohumeral distance (axCHD), sagittal coracohumeral distance (sagCHD), coracoid overlap (CO), and coracoid angle (CA) were measured.

All measurements were performed by a level 3 orthopedic surgeon according to the classification system described by Tang and Giddins, and the mean of the three measurements used for analysis.[11]

The axCHD represents the distance from the coracoid process to the humerus on axial images, while the sagCHD represents this distance on sagittal images. Coracoid overlap refers to the distance between the tip of the coracoid process and the plane of the glenoid articular surface in the transverse MRI plane.

The coracoid angle is defined as the angle between the coracoid tip and its base, reflecting the shape of the coracoid process (Figure 1).

Statistical Analysis

All data were analyzed using IBM SPSS Statistics version 27.0 (IBM Corp., Armonk, NY, USA). Continuous variables were reported as either mean ± standard deviation (SD) or median with interquartile range (IQR), depending on distribution characteristics. Categorical data were summarized as counts and percentages.

Comparative analyses between the groups were conducted using the independent t-test or the Mann–Whitney U test for continuous variables (depending on normality) and the chi-square test or Fisher's exact test for categorical variables.

To evaluate the diagnostic utility of morphologic parameters, receiver operating characteristic (ROC) curve analysis was performed. A *p*-value below 0.05 was considered to indicate statistical significance throughout all analyses.

RESULTS

A total of 161 patients whose MRI scans were evaluated were included in the study. A subscapularis tear was present in 18 patients (11.2%). Seventy patients (43.5%) were male. The mean age was 58.2 ± 7.5 years. In Group I, a subscapularis tear was present on the dominant side in 11 (61.1%) patients, whereas in Group II, it was present in 83 (58.1%) patients.

Based on the Lafosse classification, the tear types in Group I distributed as follows: 1 patient with type 1, 10 with type 2, 6 with type 3, and 1 with type 4. The demographic data are summarized in Table 1.

The comparison of mean ages between groups revealed no statistically difference (*p* =

Table 1. Clinical characteristics of the patients.

	Subscapularis Tear (+) (*n* = 18)	**Subscapularis Tear (-) (*n* = 143)**	**Total**	***p*-value**
Age	59.33 ± 8.67	58,03 ± 7.37	58.2 ± 7.5	0.549
Gender				
Male	7 (38.8%)	63 (44.1%)	70 (43.5%)	0.869
Dominant Side	11 (61.1%)	83 (58.1%)	94 (58.4%)	1.000
Lafosse Classification				
Type 1	1 (5.5%)			
Type 2	10 (55.5%)			
Type 3	6 (33.3%)			
Type 4	1 (5.5%)			
Type 5	0 (0.0%)			

*SD: standard deviation

Table 2. MRI based measurements of coracoid morphology and their relationship with subscapularis tear.

	Subscapularis Tear	*n*	Mean ± (SD)	*p*-value
Age	YES	18	59.33 ± 8.67	0.489
	NO	143	58,03 ± 7.37	
Axial coracohumeral distance	YES	18	7,05 ± 2.23	0.003
	NO	143	9,38 ± 3.18	
Sagittal coracohumeral distance	YES	18	8,60 ± 1.43	< 0.001
	NO	143	11,65 ± 2.67	
Coracoid overlap	YES	18	20,31 ± 3.74	<0.001
	NO	143	16,52 ± 4.36	
Intracoracoid angle	YES	18	78,46 ± 8.04	0.057
	NO	143	81,73 ± 6.62	

*SD: standard deviation

Table 3. ROC analysis of coracoid measurements

	AUC (%95 CI)	Cut-off (mm)	*p*	Sensitivity (%)	Specifity (%)
AxCHD	0.74 (0.64-0.84)	< 7.93	0.001	77.8	72.7
SagCHD	0.84 (0.78-0.91)	< 9.55	0.000	77.8	80.4
CO	0.73 (0.62–0.85)	> 19.77	0.001	72.2	74.8

*AUC: area under curve, CI: confidence interval, axCHD: axial coracohumeral distance, sagCHD: sagittal coracohumeral distance, CO: coracoid overlap

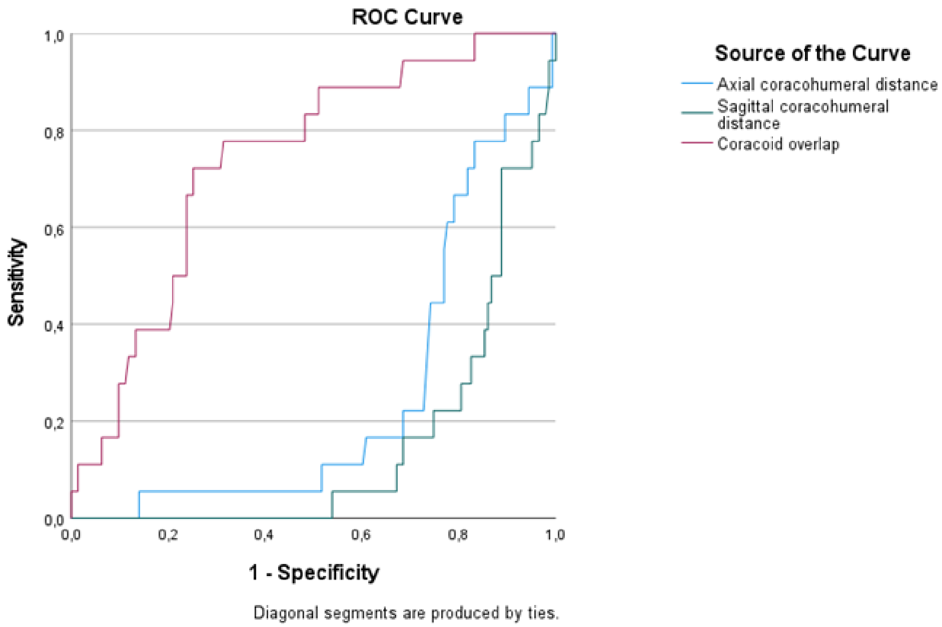

Figure 2. Diagnostic accuracy of sagittal coracohumeral distance (sagCHD), axial coracohumeral distance (axCHD) and coracoid overlap (CO) as shown in ROC analysis.

0.489). Table 2 summarizes the comparison of coracoid-related MRI measurements between the two groups. The axCHD, sagCHD, and CO measurements were significantly different between the groups (p = 0.003, < 0.001, and < 0.001, respectively). The intracoracoid angle was similar in both groups (p = 0.057).

Table 3 presents the ROC analysis of the measurements that were statistically significant. The parameter with the highest AUC value was sagCHD, with an AUC of 0.84 (0.78–0.91). Its cut-off value was 9.55 mm, with a sensitivity of 77.8% and a specificity of 80.4%. The cut-off value for axCHD was 7.93 mm, with a sensitivity of 77.8% and a specificity of 72.7%. For CO, the cut-off value was 19.77 mm, with a sensitivity of 72.7% and a specificity of 74.8% (Figure 2).

DISCUSSION

This study revealed a significant association between specific coracoid morphological parameters and subscapularis tendon tears. In particular, reduced axial and sagittal coracohumeral distances (axCHD and sagCHD) and increased coracoid overlap were strongly associated with subscapularis pathology. Among these, the sagittal CHD demonstrated the highest diagnostic performance, with an AUC of 0.84, suggesting its potential utility as a reliable radiologic marker for detecting subscapularis tendon tears.

Subcoracoid impingement has emerged as a notable etiological factor in the pathogenesis of subscapularis tears. The proximity of the coracoid process to the lesser tuberosity and anterior humeral head plays a crucial mechanical role in compressing the subscapularis tendon during shoulder movements such as forward flexion and internal rotation. Several studies have supported this notion. Balke et al. demonstrated that a coracohumeral distance of less than 6 mm on axial MRI was significantly predictive of subscapularis tendon injury, a finding that closely parallels the cut-off values identified in the present study using sagittal imaging planes.[12] Although Çetinkaya et al. did not find an association between CHD and subscapularis tears, the overall literature tends to support the opposite.[13] El Amin et al. reported that CHD was significantly lower in patients with subscapularis tears compared to both the normal population and those with supraspinatus tears.[14] Similarly, Yu et al. stated that CHD was the most predictive measurement for subcoracoid impingement.[15]

Furthermore, increased coracoid overlap has been shown to decrease the volume of the subcoracoid space, potentially contributing to repetitive mechanical irritation of the subscapularis tendon. Our findings are consistent with the findings of the Mi et al. study, which stated that the most predictive value was CO with a cut-off value of 19.79 mm.[16]

Interestingly, our study did not observe a statistically significant relationship between the coracoid angle and subscapularis tears. However, previous studies in the literature have reported a potential relationship between these parameters. For instance, Watson et al. demonstrated that a decreased coracoid angle in sagittal plane was significantly associated with subscapulris tears.[17] Similarly, Leite et al. reported that a decreased coracoid angle is a strong predictor of subscapularis tears and proposed a classification system for coracoid morphology.[18] Variations in study methodology, inclusion criteria, or sample characteristics may account for the inconsistencies observed when comparing our results to prior research.

In our study, no significant association was found between age and the presence of subscapularis tears. However, several previous studies have reported age as a contributing factor. For example Dugarte et al demonstrated that the prevelance of subscapularis tears increases with age, suggesting age-related degenerative changes as a potential underlying mechanism.[19] The mean age in our study was lower than that of the "older patient" group reported by Dugarte et al., which may account for the observed difference. Similarly, Kucukciloglu et al. reported that incidence of subscapularis lesions increases with age.[20] However, their study also included lesions such as tendinosis and tendinitis, which may explain the difference in sample composition compared to our study.

These findings provide valuable insights into the underlying biomechanical environment contributing to subscapularis injury. The anatomical configuration of the coracoid process—specifically its proximity to the humeral head—should be carefully evaluated in preoperative MRI assessments of patients with anterior shoulder pain or suspected rotator cuff pathology. Recognition of morphologic parameters such as CHD and CO can assist clinicians in identifying patients at higher risk for subcoracoid impingement and guide the surgical approach, particularly in procedures involving coracoplasty or subscapularis repair.

This study has several limitations. The

retrospective design may have introduced inherent biases related to patient selection. Additionally, all measurements were performed by average of three observers, and inter- or intra-observer reliability analyses were not conducted.

CONCLUSION

In conclusion, this study demonstrates that specific MRI-based morphologic features of the coracoid process—particularly reduced coraco-humeral distance and increased coracoid overlap—are associated with subscapularis tendon tears. These parameters may serve as valuable diagnostic indicators in the evaluation of rotator cuff pathology and should be considered during preoperative imaging assessment.

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CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest related to this study.

ETHICAL APPROVAL

This retrospective study was initiated with the approval of the U.H.S Istanbul Training and Research Hospital Clinical Research Ethics Committee (Decision No. 176), dated July 11, 2025.

DATA AVAILABILITY STATEMENT

The data support the findings of this study are avaliable from corresponding author upon reasonable request.

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