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Clinical Significance of the Coraco-Humeral Distance in Patients with Subscapularis Tendon Tear: A Single-Center, Retrospective Study

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Clinical Significance of the Coraco-Humeral Distance in Patients with Subscapularis Tendon Tear: A Single-Center, Retrospective Study

Running title: Coracohumeral Distance and Subscapularis Tendon Tear

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Abstract

We conducted this study to identify a correlation between the coraco-humeral distance (CHD) and the subscapularis tendon tears (SSCTs) in a single-institution setting. A total of 670 patients (n = 670) were included in the current study; they comprise 488 men (72.8%) and 182 (27.2%), whose mean age was 59.32 ± 12.58 years old. Depending on the presence of the SSCT and supraspinatus tendon tear (SST), they were divided into three groups: the control group (n = 179; the patients without SSCT and SST), the SSCT group (n = 133; those with SSCT only) and the SSCT+SST group (n = 358; those with both SSCT and SST). This is followed by comparison of the CHD between the three groups. The CHD was significantly greater in the control group as compared with the SSCT group and the SSCT+SST group ($P < 0.05$). In conclusion, our results indicate that there is a possible relationship between the CHD and SSCT. But further large-scale, multi-center studies are warranted to establish our results.

Keywords: shoulder pain; rotator cuff; rotator cuff injuries; shoulder impingement syndrome; magnetic resonance imaging

1. Introduction

Shoulder pain causes a high health care cost, and it has a serious impact on the quality of life of affected individuals. It mainly occurs as a result of rotator cuff problems at an incidence of 20.7% in the general population, and its prevalence is increased with age [1].

The rotator cuff is composed of four muscles and their tendons: supraspinatus, infraspinatus, teres minor and subscapularis. Collagen bundles arise from the tendons, and they constitute a cover that surrounds the humeral head and thereby are involved in the rotation of the arm. In addition, the four muscles and tendons also play a role in stabilizing the humeral head against the glenoid [2]. Thus, the four muscles and tendons of the rotator cuff each play a key role in the motion of the shoulder. Of these, the supraspinatus tendon is mainly involved in *not only* the initiation of the first 30° of forward flexion *but also* the assistance of the deltoid with the first 90° of abduction and the external rotation of the humerus [3]. Both the infraspinatus and teres minor are involved in the external rotation of the proximal humerus [4].

Rotator cuff tears (RCTs) are a common cause of shoulder dysfunction, thus having a detrimental impact on the activities of daily living (ADL), an ability to work and sports-related activities of affected individuals [5]. According to cohort studies, their prevalence is estimated at 20.7% in patients with a mean age of 58 years. This is accompanied by a report that patients with asymptomatic RCT

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account for 65% of total cases [6,7]. Individuals with older age and a past history of trauma are at increased risks of developing RCTs. Moreover, it is also known that dominant arm is vulnerable to them [6,8]. But female sex, longer years of education and a higher strength of forward elevation and abduction are factors contributing to improvements in pain and function in patients with RCTs [9,10].

Symptoms of RCT vary depending on sites of affection. In addition, although variable, a partial-thickness RCT is more prevalent as compared with a full-thickness one. Furthermore, a partial-thickness supraspinatus tear is the most prevalent case [11].

According to autopsy and cadaveric studies, the incidence of subscapularis tendon tears (SSCTs) ranges between 3% and 13% [12]. More recently, there is a growing interest in the SSCT; considerable efforts have been made to diagnose and treat it [13]. Thus, there has been an increase in the identification of the SSCT with technological advances in imaging modalities [12,13].

The coraco-humeral distance (CHD) is a length extending from the lesser tuberosity and the humerus. It is associated with subcoracoid impingement that is an unusual form of shoulder impingement that results from narrowing of the CHD [14,15]. Its causative factors include idiopathic, traumatic or iatrogenic ones. Idiopathic factors include lateral orientation of the coracoid process, calcification of the supraspinatus tendon, bulky subscapularis muscle and ganglion cysts [14–17]. Traumatic factors include fractures of the humeral head and neck *as well as* malunion and displacement of fractures of the humerus and the scapula [18,19]. Iatrogenic factors include a past history of taking surgeries such as posterior glenoid osteotomy or acromionectomy [20].

The CHD has been studied using imaging modalities such as computed tomography (CT), magnetic resonance imaging (MRI) and ultrasonography [21,22]. According to a review of literatures, its values ranges between 8.7 and 11 mm. If narrowed, it would cause notable lesions in the subscapularis tendon [23,24].

Given the above background, we conducted this study to identify a correlation between the CHD and the SSCTs in a single-institution setting.

2. Methods

2.1. Study Patients and Setting

The current single-center, retrospective study was conducted in a total of 670 patients who underwent arthroscopic shoulder surgery at our medical institution between January and December, 2025.

Inclusion criteria for the current study are as follows:

(1) The patients with an MRI-confirmed rotator cuff tear

(2) The patients who underwent arthroscopic rotator cuff repair.

Exclusion criteria for the current study are as follows:

(1) The patients who underwent rotator cuff surgery

(2) The patients with a passive external rotation of <30° with the arm on their side

(3) The patients with an anterior shoulder instability

(4) The patients with a history of taking surgery for anterior shoulder instability

(5) The patients with a history of shoulder fracture

(6) The patients with systemic inflammatory diseases (*e.g.*, such as rheumatoid arthritis).

We therefore enrolled a total of 670 (n = 670) patients in the current study; it was approved by the Institutional Review Board (IRB) of Bundang Jesaeng Hospital (IRB No. DMC 2024-06-002). Informed consent was waived due to its retrospective nature.

2.2. Measurement of the CHD

The CHD was measured on axial MRI scans according to the methods proposed by Tan et al. [25,26]. To raise the accuracy of measurement, its value was obtained twice and then selected based on consensus between the two board-certified specialists in orthopedic surgery.

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2.3. MRI Protocol and Analysis

We used the MAGNETOM® Avanto 1.5T (Siemens, Erlangen, Germany) with a dedicated shoulder coil, a field of view of 16-cm, slice thickness of 3-mm with a 0.6-mm gap and matrix of 256 × 320. All the patients were laid in a supine position with their arm placed by their side. In addition, they had their palm face upward and the external rotation of their shoulder was maintained accordingly. Furthermore, they had their subscapularis tendon stretched.

Sagittal oblique T2-weighted fast spin echo (TR/effective TE = 2500-6000/80-90; echotrain length = 8), coronal oblique T1-weighted spin echo (400-800/8-12), coronal oblique T2-weighted fast spin echo (2500-6000/60-80; fat suppressed; echo-train length, 8) and axial T2-weighted fast spin echo (2500-6000/60-80; fat suppressed; echo-train length, 8) images were obtained.

MRI scans were analyzed by two board-certified specialists in orthopedic surgery, and they were blinded to arthroscopic findings of the patients' shoulder.

The subscapularis tendon was classified as normal or abnormal according to the criteria as follows:

(1) A tear is defined as a disruption of tendon fibers showing a high T2 signal and equal to that of water [37].

(2) A full-thickness tear is defined as a complete tearing of tendon fibers extending from the superior to inferior surface of the tendon with intervening bright fluid signals.

(3) A partial-thickness tear is defined as a partial tendon disruption by intervening bright fluid signals that do not reach the surface of the tendon [28].

We finally analyzed the axial MRI scans where the coracohumeral distance was measured.

2.4. Patient Evaluation and Criteria

Our clinical series of the patients were divided into three groups: the control group, the SSCT group and the SSCT+SST group.

The control group comprises the patients without SSCT and SST undergoing arthroscopic shoulder surgery due to other causes than RCTs, thus including those undergoing arthroscopic labrum repair or acromioplasty. In addition, the SSCT group comprises the patients with an MRI- or arthroscopy-confirmed SSCT. Furthermore, the SSCT+SST group comprises the patients with a concurrent presence of MRI- or arthroscopy-confirmed SST.

In our series, we performed a retrospective review of the medical record; baseline characteristics include age, sex, biceps tendon dislocation, Goutallier classification (stage 0-4) and CHD. In addition, we also compared the CHD between the three groups.

2.5. Statistical Analysis

All data was expressed as mean ± standard deviation. Statistical analysis was performed using SPSS 31 for windows (SPSS Inc., Chicago, IL). Baseline characteristics of the patients were analyzed using the χ^2-test. In addition, statistical significance in differences in measurements was analyzed using the repeated measures analysis of variance (ANOVA). A P-value of < 0.05 was considered statistically significant.

3. Results

3.1. Baseline Characteristics of the Patients

A total of 670 patients (n = 670) were included in the current study; they comprise 488 men (72.8%) and 182 (27.2%), whose mean age was 59.32 ± 12.58 years old. Baseline characteristics of the patients are represented in Table 1. Moreover, baseline characteristics of the patients of each group are represented in Table 2.

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Table 1. Baseline characteristics of the patients.

Variables	Values
Age (years)	59.32 ± 12.58
Sex	
Men	488 (72.8%)
Women	182 (27.2%)
Biceps tendon dislocation	22 (3.3%)
Goutallier classification	
Stage 0	438 (65.4%)
Stage 1	171 (25.5%)
Stage 2	47 (7.0%)
Stage 3	12 (1.8%)
Stage 4	2 (0.3%)
CHD (mm)	9.92 ± 2.78

Abbreviations: CHD, coracohumeral distance.

Values are mean ± standard deviation with range or the number of patients with percentage, where appropriate.

Table 2. Baseline characteristics of the patients in each group.

Variables	Values		
	Control group	SSCT group	SSCT+SST group
Age (years)	50.59 ± 15.39	62.95 ± 9.15	62.33 ± 9.77
Sex			
Men	142 (79.3%)	97 (72.9%)	249 (69.6%)
Women	37 (20.7%)	36 (27.1%)	109 (30.4%)
Biceps tendon dislocation	0 (0.0%)	17 (12.8%)	5 (1.4%)
Goutallier classification			
Stage 0	137 (76.5%)	71 (53.4%)	230 (64.2%)
Stage 1	35 (19.6%)	43 (32.3%)	93 (26.0%)
Stage 2	7 (3.9%)	13 (9.8%)	27 (7.5%)
Stage 3	0 (0.0%)	5 (3.8%)	7 (2.0%)
Stage 4	0 (0.0%)	1 (0.8%)	1 (0.3%)
CHD (mm)	11.62 ± 2.97	9.29 ± 2.50	9.30 ± 2.40

Abbreviations: CHD, coracohumeral distance.

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Values are mean ± standard deviation with range or the number of patients with percentage, where appropriate.

3.2. Correlation Between the SSCT and the CHD

The CHD was significantly greater in the control group as compared with the SSCT group and the SSCT+SST group ($P < 0.05$).

4. Discussion

To date, attempts have been made to clarify etiology and pathogenesis of SSCT. It has therefore been reported that subcoracoid impingement might cause anterior shoulder pain and thereby be involved in the pathology of shoulder [29]. This is followed by published studies showing that there is a causal relationship between the subcoracoid stenosis and full- or partial-thickness RCTs, including SSCT. These studies suggest that the SSCT may occur as a result of the high tensile load applied to the posterior aspect of the tendon when it arches across the prominent coracoid in a stenotic subcoracoid space [30–32]. Then, imaging modalities have been used to quantified the CHD, thus showing that it is decreased in patients with biceps tendon pathology, subcoracoid impingement or RCTs [33,34].

It has been reported that there is a significant correlation between a narrowed CHD and an increased incidence of RCTs. Moreover, a narrowed CHD may occur as a result of fat infiltration into the supraspinatus and infraspinatus muscles. Furthermore, normal healthy individuals and affected individuals had a mean CHD of 11.2 and 6.7 mm, respectively, during the maximal rotation of the shoulder [35,36].

Subcoracoid impingement is an uncommon cause of chronic anterior shoulder pain [37]. It is commonly diagnosed based on clinical symptoms *as well as* physical examination. But it has been neglected in patients who are not suspected of having clinical signs and symptoms that are suggestive of it. Efforts have been made to establish a cut-off value of the CHD in making a diagnosis of subcoracoid impingement. Still, however, controversial opinions exist regarding the diagnostic performance of imaging studies [38–40].

In the current study, our results showed that the CHD was significantly greater in the control group as compared with the SSCT group and the SSCT+SST group (P<0.05). But this cannot be generalized because there is no established cut-off value of the CHD in the diagnosis of subcoracoid impingement.

According to a review of previous studies, the CHD of <6-10 mm is suggestive of subcoracoid stenosis [39,40]. On the other hand, the CHD on imaging studies could not be a diagnostic clue to subcoracoid impingement. In more detail, Giaroli et al. reported that the CHD on imaging studies had a sensitivity of 5.3% and a specificity of 97.6% in the diagnosis of subcoracoid impingement at its cut-off value of 5.5mm according to a previous study by Friedman et al. [41,42]. Hekimoğlu et al. performed a receive operating characteristic curve analysis, thus drawing a conclusion that a cut-off value of the CHD could not be determined at a sensitivity and specificity of 80-90% of imaging modalities in the diagnosis of subcoracoid impingement [38]. This is in agreement with previous published studies showing that the CHD on MRI scans could not be a diagnostic clue to subcoracoid impingement despite a possible relationship between the CHD and subcoracoid impingement [38,40,42].

In conclusion, our results indicate that there is a possible relationship between the CHD and SSCT. But further large-scale, multi-center studies are warranted to establish our results.

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Institutional Review Board Statement: The current study was conducted in compliance with the relevant ethics guidelines following the approval by the Institutional Review Board (IRB) of Bundang Jesaeng Hospital (IRB No. DMC 2024-06-002). All procedures described herein were performed in accordance with the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards. But informed consent was waived due to its retrospective nature, as granted by the IRB of our hospital in Korea.

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Conflicts of Interest: The authors have nothing to declare in relation to this work.

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