The Egyptian Journal of Radiology and Nuclear Medicine 48 (2017) 977–981

Contents lists available at ScienceDirect

The Egyptian Journal of Radiology and Nuclear Medicine

journal homepage: www.sciencedirect.com/locate/ejrnm

Original Article

# Narrowed coraco-humeral distance on MRI: Association with subscapularis tendon tear

Ahmed M. Abdrabou *, Mennatallah H. Shalaby

*Radiodiagnosis Department, Faculty of Medicine, Ain-Shams University, Cairo, Egypt*

ARTICLE INFO

*Article history:*
Received 19 September 2016
Accepted 29 April 2017
Available online 12 December 2017

*Keywords:*
Subscapularis
Coracoid process
Coraco-humeral
Shoulder

ABSTRACT

*Purpose:* To highlight the relationship between coraco-humeral distance and subscapularis tendon tear.
*Material and methods:* Sixty-two shoulder MRI studies were examined. Twenty-two patients had partial or complete tear of subscapularis tendon and forty shoulder as a control group. Axial and oblique sagittal MR images were examined to measure the coraco-humeral distance followed by statistical analysis to correlate the distance with tendon tear.
*Results:* A cut-off value of 8.25 mm for the coraco-humeral distance gave a sensitivity of 77.5% and specificity of 72.7% for subscapularis tendon tear.
*Conclusion:* There is a well-known relationship between the coraco-humeral distance and the subscapularis tendon tear and its meticulous assessment in subjects with pain in the anterior shoulder region increases the diagnosis of subcoracoid impingement.


## 1. Introduction

Isolated subscaspularis (SS) tears are not common and are usually preceded by trauma [1]. The SS tears are usually associated with supraspinatus (SSP) tendon full-thickness tears [2].

It is well known that SS tendon tears cause shoulder pain [3]. The origin of the SS muscle is from the scapular fossa and its insertion is on the lesser tuberosity [1]. The superior surface of the tendon is frequently injured in majority of the SS tendon lesions, whereas the inferior surface is injured in extensive lesions [4]. The SS tendon tears may be a part of an extensive rotator cuff tear, rotator interval lesions, or occur seperately [5,6].

Complete tearing of the SS tendon that occurs in isolation is uncommon. It is usually preceded by externally rotating the adducted arm vigorously, or repeated anterior instability and anterior shoulder dislocation [1,5,7]. It is also less common than that occurring as a sequel of a massive SSP tendon tear extending anteriorly [7–10].

The coraco-humeral distance (CHD) is the distance extending between the lesser tuberosity and the humerus. It leads to subcoracoid impingement (SC) which is relatively an infrequent entity occurring due to an encroaching lesser tuberosity against the coracoid process [11–13].

Structures which are liable to impingement include SS tendon, long head of biceps tendon and the middle glenohumeral ligament [14].

It could be either idiopathic or traumatic or iatrogenic. Idiopathic causes occur due to an underlying to an abnormal laterally oriented coracoid, calcified SS tendon or bulky SS muscle, ganglion cysts [11–13,15,16]. Traumatic factors involve fractures of the humeral head and neck, malunited and displaced fractures of the humerus and the scapula [17–19]. Previous surgical procedures like posterior glenoid osteotomy and acromionectomy may cause a reduced CHD as well [20].

Several studies have described CHD, using computed tomography (CT), magnetic resonance imaging (MRI) and Ultrasonography [21–23].

The available literature reported that normal CHD ranges from 8.7 mm to 11 mm. It is stated that a narrowed CHD leads to remarkable lesions in the tendon of the SS muscle [24–26].

So, in this study, our objective was to confirm that there is a significant association between a narrowed CHD and SS tendon tears.

Peer review under responsibility of The Egyptian Society of Radiology and Nuclear Medicine.
* Corresponding author.
*E-mail addresses:* ahmed.abdrabou@med.asu.edu.eg (A.M. Abdrabou), mennatshalaby@yahoo.com (M.H. Shalaby).

https://doi.org/10.1016/j.ejrnm.2017.04.011
0378-603X/

## 2. Materials and methods

### 2.1. Patients

A retrospective study was undertaken over 12 month's period from March 2015 to March 2016. A preoperative MRI was performed on 62 shoulders and was compared with the arthroscopy results. It was divided into: a SS group and an asymptomatic control group.

The SS group included 22 subjects (22 shoulders) which consisted of all subjects who were clinically suspected to have SC impingement. They were proved via arthroscopy to have SS tendon partial or full thickness tear. Subjects who presented with SSP tear were excluded. All subjects presented with anterior shoulder pain, inability to abduct the arm shoulder and difficulty in overhead arm elevation. They were evaluated in the orthopaedic clinic using the coracoid impingement test which tests cross arm adduction, forward elevation and internal rotation of the arm.

There were 40 subjects (40 shoulders) in the asymptomatic group who had no arthroscopic evidence of SS tendon tear and they underwent arthroscopy for a variety of other clinic-pathological conditions e.g. tears of the labra, capsular release, SSP repair or for diagnostic aim.

### 2.2. MRI protocol

The studies were performed using a 1.5-T unit (Signa, GE Healthcare) with a dedicated shoulder coil, a field of view of 14-cm, slice thickness of 4-mm with a 1-mm gap, and matrix of 256 × 256. All patients were imaged in a supine position with their arm by their side, palm faces upward to maintain external shoulder rotation and stretch the subscapularis tendon. Sequences obtained were 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).

### 2.3. MR images analysis

Two radiologists (Abdrabou A and Shalaby M) thoroughly scrutinized the MR scans. They are specialized in musculoskeletal radiology and were blinded from the arthroscopy results.

The SS tendon was classified into normal or abnormal according to the following imaging criteria: A tear is known as disruption of tendon fibers which show a high T2 signal and equal to that of water [4,27,28]. A full-thickness tear is known as complete tearing of tendon fibers which extend from the superior to the inferior surface of the tendon with intervening fluid bright signal. Partial-thickness tear is known as partial tendon disruption by intervening fluid bright signal but not reaching the surface of the tendon [2].

There are other helpful signs in the diagnosis SS tendon lesions which were evaluated. They include: (a) fatty changes infiltrating the SS muscle, (b) lesions in the biceps tendon (dislocation or subluxation) [4,29,30].

The axial scans were evaluated where the CHD was assessed by depicting the distance from the coracoid process cortical margin to the humeral head cortical margin.

The axial image where the subcoracoid stenosis was at its maximum was the one used for measuring the CHD. For further verification, this measurement was done in the oblique sagittal plane as well (Fig.1).

The CHD measured for the asymptomatic control group was compared to that of the SS group in both axial and oblique sagittal planes.

### 2.4. Statistical analysis

Our data was statistically analayzed using a Student *t* test. Statistical significance was set at P 0.05, and all differences depicted in our results were statistically significant. Data were presented as means of standard deviation (SD).

## 3. Results

The SS group included 22 subjects (22 shoulders). Their average age was 46.36 ± 14.17 years (Table 1). In this group 17 were males and 5 were females.

The asymptomatic group included 40 subjects (40 shoulders). Their average age was 37.30 ± 16.63 years. In this group 31 patients were males and 9 patients were females.

Eighteen patients had SS tendon partial thickness tear manifested as partial intrasubstance increased signal on T2WI (Fig. 2).

Four patients had SS tendon complete tear with dislocated biceps tendon as well. (Figs. 3 and 4).

Eighteen patients had SS tears associated with rotator cuff pathology, and four patients had a single SS tear.

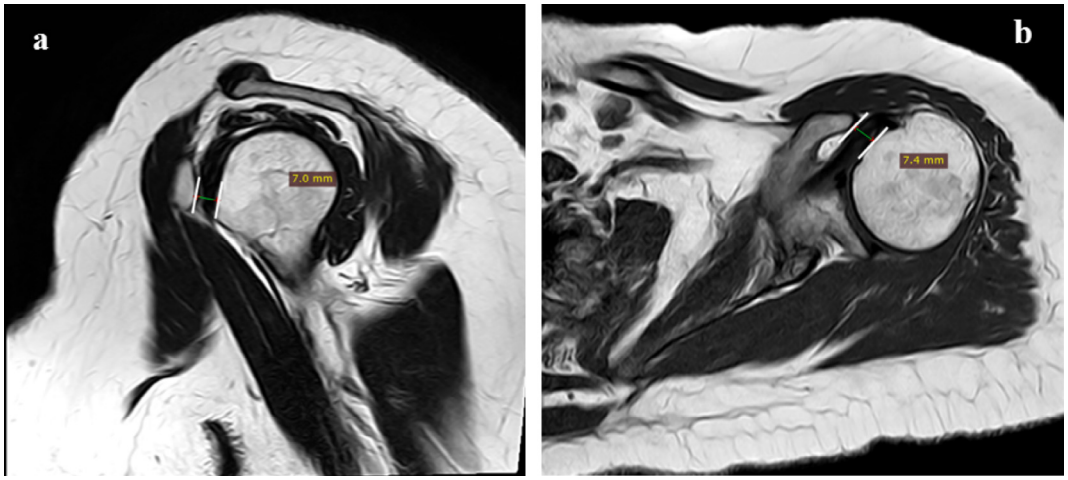


**Fig. 1.** Oblique sagittal T2 and axial T2 WI illustrate the coraco-humeral distance and how to measure. It is estimated to be 7 mm on the sagittal plane and 7.4 mm on the axial plane with average distance of 7.2 mm. Note the intact subscapularis tendon between the white lines.

**Table 1**
Statistical analysis of the SS and asymptomatic groups data.

| | Subjects N = 22 Mean ± SD (Range) | Asymptomatic N = 40 Mean ± SD (Range) | P value |
|---|---|---|---|
| Age[++] | 46.36 ± 14.17 (26–75) | 37.30 ± 16.63 (19–78) | .01[*] |
| Gender (males)[#] | 17 (77.3%) | 31 (77.5%) | .9 |
| Axial view (mm)[+] | 7.37 ± 1.20 (5–10) | 10.50 ± 2.41 (7–18) | <.05[*] |
| Sagittal view (mm)[+] | 7.92 ± 1.41 (6–11) | 10.55 ± 2.44 (7–18) | <.05[*] |
| Average distance (mm)[+] | 7.66 ± 1.19 (6–10) | 10.53 ± 2.38 (7–18) | <.05[*] |

[*] Significant p < .05.
[+] Student *t* test.
[++] Mann-Whitney *U* test.
[#] Qualitative variables are presented as number (percentage) and the test of significance is Chi square test.

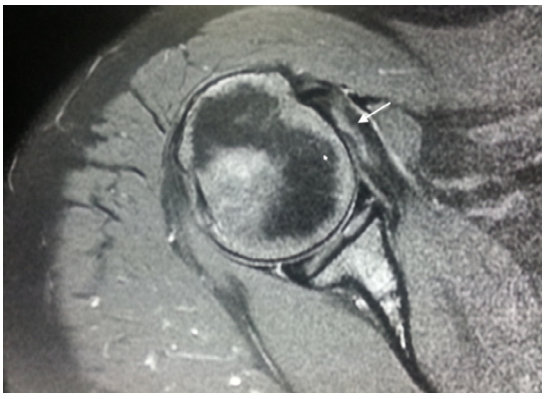

**Fig. 2.** Axial T2 Fat suppressed image of the right shoulder joint with the white arrow refers to focal increase signal intensity within the substance of the subscapularis tendon confirmed by arthroscopy to be partial tear. The coraco-humeral distance was estimated to be 6.2 mm on axial and 6.4 mm on sagittal planes.

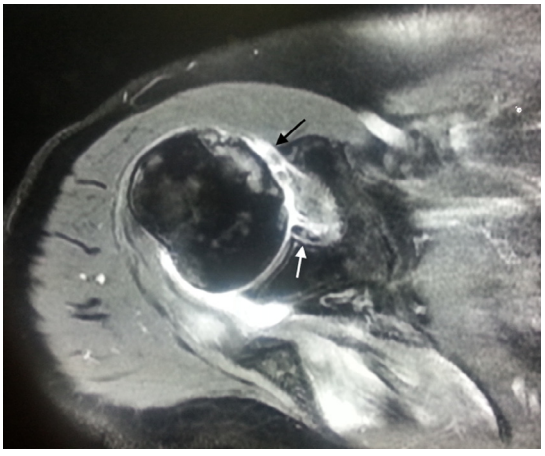

**Fig. 4.** Axial T2 fat suppressed image of another patient with completely torn subscapularis tendon (black arrow) and dislocated biceps tendon (white arrow). The coraco-humeral distance measures 5.9 mm on axial and 6.1 mm on sagittal planes.

A Student *t* test was performed to compare the SS group with the asymptomatic group. There was a statistically significant difference between the 2 groups (P < .005).

In the axial plane the CHD calculated in the SS group was 7.37 ± 1.20 mm compared to 10.50 ± 2.41 mm in the asymptomatic group with p value .00. In the sagittal oblique plane CHD in the SS group was 7.92 ± 1.41 mm compared to 10.55 ± 2.44 mm in the control group with p value <.005.

The average distance was 7.66 ± 1.19 mm in the SS group compared to 10.53 ± 2.38 mm in the control group with p value <.005.

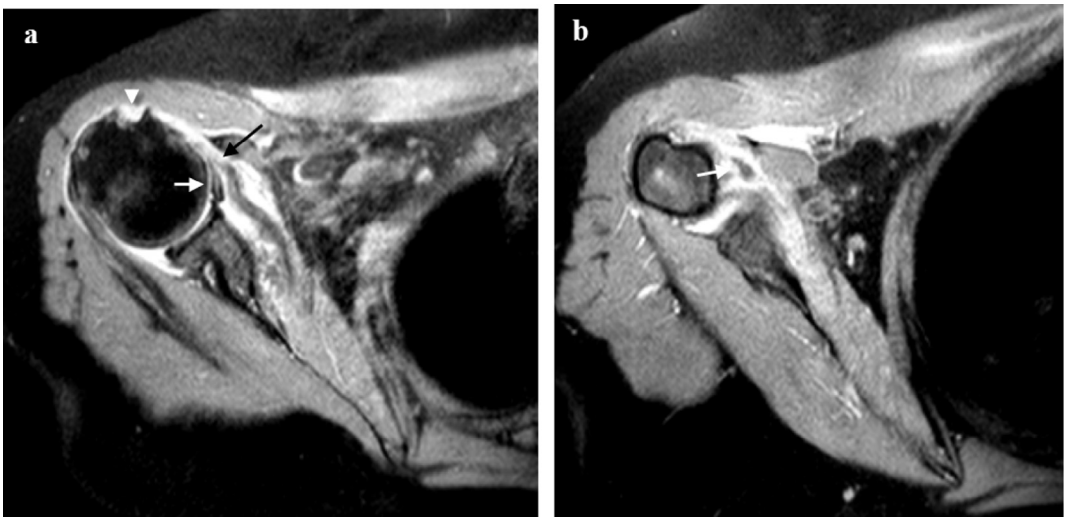


**Fig. 3.** (a) and (b) Axial T2 fat suppressed images of the right shoulder joint; the black arrow refers to the completely torn and retracted subscapularis tendon. (a) White arrow refers to the dislocated biceps tendon and white arrowheads indicates empty bicipital groove. The coraco-humeral distance was estimated to measures 5 mm in axial and 5.5 mm in sagittal planes. (b) The biceps tendon is completely dislocated as shown by white arrow.

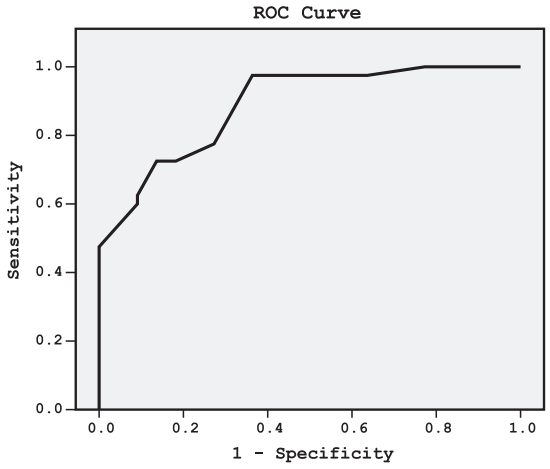


**Fig. 5.** Graph shows area under binomial receiver operating characteristic curve is 0.88 (95% CI: 0.80–0.96).

Using ROC curve, a cut off value of 8.25 mm had a sensitivity of 77.5% and a specificity of 72.7% (Fig. 5).

(We chose a cut off value of (8.25 mm) for the best prediction of SS tendon pathology. This cut off value gave a sensitivity of 77.5% and specificity of 72.7%).

## 4. Discussion

In the study done by Nove-Josserand et al. [22], they reported an influential relation between a decreased CHD and extensive rotator cuff tears. They believed that a decreased CHD is a sequel of fat infiltrating the SSP and ISP muscles and that it was not a leading cause of a SS tear. They depicted a CHD of 11.2 mm in normal subjects and 6.7 mm in affected subjects at maximal internal rotation of the shoulder [22].

Chen et al., reported a CHD of 8.7 mm in patients from Taiwan [31]. Lo and Burkhart deduced a CHD of < 6 mm for coracoplasty [32].

Another study by Lo et al., found that the CHD was 3.9 mm in anterosuperior cuff tears, compared to 10.4 mm in their asymptomatic group [23].

Friedman et al., depicted that subjects in their series with subcoracoid impingement had a CHD of 5.5 mm compared to 11 mm in their asymptomatic group in maximum internal rotation [24].

Other research work where the position was neutral or not mentioned gave higher CHD values in affected subjects [33,34].

In our study, the average distance was 7.66 ± 1.19 (range 6–10 mm) in the SS group compared to 10.53 ± 2.38 (range 7–18 mm) in the asymptomatic group with p value <.005.

We believe we had a higher cut off value than most of the available literature because our subjects were positioned in maximum external rotation so as to stretch the SS tendon and not miss any pathology.

In the study performed by Richards et al., the narrowing of the CHD was statistically significant in a group of patients who were submitted to SS surgical repair. The average CHD of their asymptomatic group also was within the depicted normal range [35].

We believe that presentation of anterior shoulder pain warrants meticulous assessment of the CHD. Establishing a limit value of 8.25 mm of CHD ensures an accurate presurgical plan.

We noted that a finding of decreased CHD may indicate a dedicated arthroscopic evaluation of the SS muscle and its relation with the coracoid. This might subsequently lead to a decision to decompress the subcoracoid space and to repair the SS muscle arthroscopically.

Giaroli et al., studied presurgical MR images in a series of 19 patients with evident SC impingement and compared them with a control group. Their objective was to assess whether the CHD obtained from conventional shoulder MRI can depict subcoracoid impingement accurately and eventually SS tendon tears [14].

Their results revealed a low specificity of MRI (44–59%), so they deduced that subcoracoid impingement is originally a clinical diagnosis and that MRI could back up this diagnosis, but cannot reliably depict it.

However, this wasn't in line with our study as we found out that a narrowed CHD by MRI is directly related to SS tendon tears. The cut off value of 8.25 mm has a sensitivity of 77.5% and a specificity of 72.7%.

It is well established that biceps tendon pathology is closely related to SS tendon lesions due to similar anatomical relations [14]. Some studies believe that a medially dislocated biceps tendon is highly diagnostic of SS tendon tear [8,9].

Pfirrmann et al. deduced that a finding of biceps tendon subluxation or dislocation, is highly suspicious of SS abnormality [26].

Our results reinforce the important value of this combination. We had 4 subjects with dislocated biceps tendon and they all had full thickness tear of SS tendon (Figs. 3 and 4).

There were some shortcomings in our study. First, the asymptomatic group did not include asymptomatic healthy age-matched subjects. It included patients presented with surgical pathological and abnormal asymptomatic shoulders. Subjects with normal shoulders in our asymptomatic group might have been the best, however our asymptomatic group results compared well with the normal values of the available literature.

Moreover, our study was not controlled for both anterior and posterior shoulder instability, which might have affected the CHD depicted by MRI.

It is known that the shape of the coracoid process plays a vital role in determining the prognosis of SC impingement which mandates further research and will be covered in our future research.

The intrasubstance SS tendon tears might be missed by arthroscopy. These tears were not identified when there was an intrasubstance tendon degeneration (intratendinous tear) especially when the outer surface of the tendon was intact during arthroscopy.

In conclusion, we believe that there is significant association with narrowed CHD and SS tendon tear and should warrant thorough examination of the SS tendon during arthroscopy.

CHD below the cut value of 8.25 mm should also alert the radiologist that SC impingement is to be highly suspected especially if clinical data is not available.

## References

[1] Gerber C, Krushell RJ. Isolated rupture of the tendon of the subscapularis muscle: clinical features in 16 cases. J Bone Joint Surg Br 1991;73:389–94.
[2] Bergin D, Parker L, Zoga A, Morrison W. Abnormalities on MRI of the subscapularis tendon in the presence of a full-thickness supraspinatus tendon tear. AJR 2006;186:454–9.
[3] Li X, Fallon J, Egge N, Curry EJ, Patel K, Owens BD, et al. MRI study of associated shoulder pathology in patients with full-thickness subscapularis tendon tears. Orthopedics 2013;36(1):e44–50.
[4] Zlatkin MB, Iannotti JP, Robert MC, et al. Rotator cuff tears: diagnostic performance of MR imaging. Radiology 1989;172:223–9.
[5] Clark JM, Harryman DT. Tendons, ligaments and capsule of the rotator cuff: gross and microscopic anatomy. J Bone Joint Surg Am 1992;74:713–25.
[6] Deutsch A, Altchek D, Veltri D, et al. Traumatic tears of the subscapularis tendon: clinical diagnosis, magnetic resonance imaging findings, and operative treatment. Am J Sports Med 1997;25:13–22.
[7] Symeonides PP. The significance of the subscapularis muscle in the pathogenesis of recurrent anterior dislocation of the shoulder. J Bone Joint Surg Br 1972;54:476–83.
[8] Nove-Josserand L, Gerber C, Walch G. Lesions of the anterosuperior rotator cuff. In: Warner JJP, Iannotti JP, Gerber C, editors. Complex and revision problems in shoulder surgery. Philadelphia, PA: Lippincott-Raven; 1997. p. 165–76.
[9] Warner JJP, Answorth AA, Gerber C. Diagnosis and management of subscapularis tendon tears. Tech Orthop 1994;9:116–25.

[10] Walch G, Nove-Josserand L, Levigne C, Renaud E. Tears of the supraspinatus tendon associated with "hidden" lesions of the rotator interval. J Shoulder Elbow Surg 1994;3:353–60.
[11] Arrigoni P, Brady PC, Burkhart SS. Calcific tendonitis of the subscapularis tendon causing subcoracoid stenosis and coracoid impingement. Arthroscopy 2006;22(10):1139. e1–3.
[12] Franceschi F, Longo UG, Ruzzini L, Rizzello G, Denaro V. Arthroscopic management of calcific tendinitis of the subscapularis tendon. Knee Surg Sports Traumatol Arthrosc 2007;15(12):1482–5.
[13] Peidro L, Serra A, Suso S. Subcoracoid impingement after ossification of the subscapularis tendon. J Shoulder Elbow Surg 1999;8(2):170–1.
[14] Giaroli EL, Major NM, Lemley DE, Lee J. Coracohumeral interval imaging in subcoracoid impingement syndrome on MRI. AJR 2006;186:242–6.
[15] Schöffl V, Schneider H, Küpper T. Coracoid impingement syndrome due to intensive rock climbing training. Wilderness Environ Med 2011;22(2):126–9.
[16] Terabayashi N, Fukuta M, Ito Y, Takigami I, Nishimoto Y, Shimizu K. Shoulder impingement syndrome due to a ganglion cyst below the coracoacromial ligament: a case report. J Bone Joint Surg Am 2011;93(8):e36.
[17] Dines DM, Warren RF, Inglis AE, Pavlov H. The coracoid impingement syndrome. J Bone Joint Surg Br 1990;72:314–6.
[18] Patte D. The subcoracoid impingement. Clin Orthop 1990;254:55–9.
[19] Kowalsky MS, Bell JE, Ahmad CS. Arthroscopic treatment of subcoracoid caused by lesser tuberosity malunion: a case report and review of the literature. J Shoulder Elbow Surg 2007;16(6):e10–4.
[20] Freehill MQ. Coracoid impingement: diagnosis and treatment. J Am Acad Orthop Surg 2011;19(4):191–7.
[21] Tan V, Moore S, Omarini L, Kneeland JB, Williams GR, Iannotti JP. Magnetic resonance imaging analysis of coracoid morphology and its relation to rotator cuff tears. Orthopedics 2002;25:329–33.
[22] Nove-Josserand L, Boulahia A, Levigne C, et al. Coracohumeral space and rotator cuff tears. Rev Chir Orthop Reparatrice Appar Mot 1999;85:677–83.
[23] Lo IKY, Parten PM, Burkhart SS. Combined subcoracoid and subacromial impingement in association with anterosuperior rotator cuff tears: an arthroscopic approach. Arthroscopy 2003;19:1068–78.
[24] Friedman RJ, Bonutti PM, Genez B. Cine magnetic resonance imaging of the subcoracoid region. Orthopedics 1998;21:545–8.
[25] Gerber C, Terrier F, Ganz R. The subcoracoid space: an anatomic study. Clin Orthop 1987;215:132–8.
[26] Pfirrmann CW, Zanetti M, Weishaupt D, Gerber C, Hodler J. Subscapsularis tendon tears: detection and grading at MR arthrography. Radiology 1999;213:709–14.
[27] Rafii M, Firooznia H, Sherman O, et al. Rotator cuff lesions: signal patterns at MR imaging. Radiology 1990;177:817–23.
[28] Kneeland JB, Middleton WD, Carrera GF, et al. MR imaging of the shoulder: diagnosis of rotator cuff tears. AJR 1987;149:333–7.
[29] Chan TW, Dalinka MK, Kneeland JB, Chervrot A. Biceps tendon dislocation: evaluation with MR imaging. Radiology 1991;179:649–52.
[30] Zanetti M, Weishaupt D, Gerber C, Hodler J. Tendinopathy and rupture of the tendon of long head of biceps brachii muscle: evaluation with MR arthrography. AJR 1998;170:1557–61.
[31] Chen Y-P, Ho W-P, Chuang T-Y. Arthroscopic management of calcific tendonitis of the subscapularis tendon with subcoracoid stenosis. J Orthopaedic Sci 2015;20(5):935–8.
[32] Lo IK, Burkhart SS. The etiology and assessment of subscapularis tendon tears: a case for subcoracoid impingement, the roller-wringer effect, and TUFF lesions of the subscapularis. Arthrosc: J Arthrosc Related Surg 2003;19 (10):1142–50.
[33] Oh JH, Song BW, Choi JA, Lee GY, Kim SH, Kim DH. Measurement of coracohumeral distance in 3 shoulder positions using dynamic ultrasonography: correlation with subscapularis tear. Arthrosc: J Arthrosc Related Surg: Off Publicat Arthrosc Assoc North Am Int Arthrosc Assoc 2016;32 (8):1502–8.
[34] Bergin D, Parker L, Zoga A, Morrison W. Abnormalities on MRI of the subscapularis tendon in the presence of a full-thickness supraspinatus tendon tear. AJR Am J Roentgenol 2006;186(2):454–9.
[35] Richards DP, Burkhart SS, Campbell SE. Relation between narrowed coracohumeral distance and subscapularis tears. Arthroscopy 2005;21 (10):1223–8.