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ORIGINAL ARTICLE

MRI analysis of coracohumeral interval width and its relation to rotator cuff tear

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Abstract
Objective Coracoid impingement is an uncommon cause of the shoulder pain. It is stimulated by adduction, internal rotation and forward flexion. These positions decrease the width of the coracohumeral interval. Owing to restriction of movement, rotator cuff tendons may be overloaded. Thus, in this study, we aimed to determine whether coracoid impingement increase the tendency of rotator cuff tears.
Materials and methods Routine clinical MRI sequences of 117 shoulders were reviewed, and axial coracohumeral interval measurements were taken. Rotator cuff tendon integrity was evaluated. Relation between rotator cuff tear and coracohumeral interval width was commented statically.
Results Seventy-nine of the patients were women, 38 of them men. The average age was 44.8 ± 14.2 (14–75). The mean age of patients with rotator cuff tear was significantly higher than patients without tear ($p = 0.001$). The mean value of coracohumeral interval width was 8.853 ± 2.491 mm (min: 2.9-max: 15.8). There were no significant differences between coracohumeral interval width of women and men ($p = 0.139$). The mean value of coracohumeral interval width with rotator cuff tear was 8.362 ± 2.382, and without tear was 9.351 ± 2.520. There was a significant differences between them ($p = 0.031$).
Conclusion According to our study, there was a relationship between coracohumeral interval width and rotator cuff tear, so decreasing coracohumeral interval width may increase tendency of rotator cuff tear.

Keywords Coracoid impingement · Shoulder pain · Magnetic resonance imaging

Introduction

Coracoid impingement is a rare cause of shoulder pain. Coracohumeral interval (CI) width decreases with forward

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flexion, internal rotation and adduction [1]. Subscapularis tendon, the tendon of the long head of the biceps and middle glenohumeral ligament pass through CI (Fig. 1). There may occur damage and tear in coracoid impingement due to the compression in the tendon in the interval [2, 3].

The diagnosis of coracoid impingement has not been extensively studied, and it remains a diagnosis of exclusion based on the findings of the physical examination, the results of injections and radiographic features [4].

Gerber et al. [4, 5] measured the CI width as 8.7 mm at neutral position and 6.8 mm at forward flexion on healthy people in a study which they conducted with a computerized tomography. In the same study, they found that the average CI width is 1.4 mm less in the women.

Friedman et al. [6] measured the average CI width as 11 mm at the maximal internal rotation position in the asymptomatic patients and as 5.5 mm in the group of the symptomatic patients. They stressed that CI width narrowed significantly in the symptomatic patients group. The narrowing in CI may lead to restricted movement and excessive loading on the rotator cuff tendons.

Coracohumeral interval distance is evaluated on the magnetic resonance image (MRI) taken by making internal rotation on the patient's shoulder, whereas MRI are often taken at neutral position due to the shoulder ache. In our study, we examined the relationship between CI interval distance and rotator cuff tears in our examination of the shoulder MRI at neutral position.

In the routine shoulder MRI examinations performed due to the shoulder pain, the reporting of CI values may account for the probable cause of the pain except for the tendon damage. The indication of the rotator cuff tears with narrowed CI may be helpful in the choice of surgical or medical treatment.

There is no study in literature that investigates with MRI the relationship between CI width and rotator cuff tears. Therefore, we aimed to examine the relationship between the narrowed CI and rotator cuff tears in the examination of the shoulder MRI taken at neutral position often preferred in daily practice.

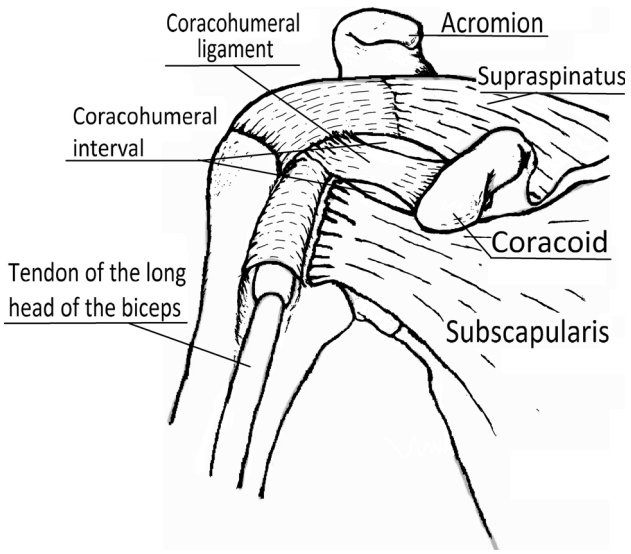

Fig. 1 The schematic drawing of the frontal view of shoulder joint showing the coracohumeral interval and associated anatomic landmarks

Materials and methods

Included in our study are 117 patients who applied to our unit with the complaints of shoulder pain between June 2013 and October 2013. MRI sequences taken routinely were re-evaluated retrospectively. The protocol was approved by our local institutional review board. The evaluation was conducted simultaneously by two radiologists who have a 5-year experience on the muscular system. All MRI was performed with a 1.5-T unit (GE Excite Scanner, GE Healthcare Technologies, Waukesha, Wis). The patient was positioned supine with the arm at his or her side at neutral position. All the studies were performed with the standard protocol, which included T1-weighted (TR range/TE range, 900/7; fast spin-echo) and T2-weighted sequences. The TR range/TE range for the T2-weighted sequences without spin-echo was 2740/42, and the TR/TE for the spin-echo T2-weighted sequences was 2200/40. For all the T2-weighted sequences, a shoulder send–receive coil was used and the number of excitations was 1–2; field of view, 16–20 cm; slice thickness, 4/0.5 mm; and matrix, 256 × 160 in three planes. Coracohumeral interval was measured in the axial gradient sequences. The measurement was conducted from the coracoid process external cortex to the humerus small tubercle (Fig. 2a). Rotator cuff tendon pathologies were evaluated from the routine sequences with consideration paid to the writing of Morav et al. [7].

The relation between rotator cuff tear and CI width was evaluated statically. SPSS 17.0 for Windows was used for the statistical analysis. The normal distribution of groups was calculated by one-sample Kolmogorov-Smirnow Test. Coracohumeral intervals of each group were normally distributed, so we used independent samples t test in comparison with CI for two groups and one-way Anova for more than two groups. Pearson correlation was used to show the correlation between continuous variables. All calculations were performed according to the two-tailed test, and $p < 0.05$ was assumed as statistically significant. Also, the box-blot graphs were drawn for CI groups.

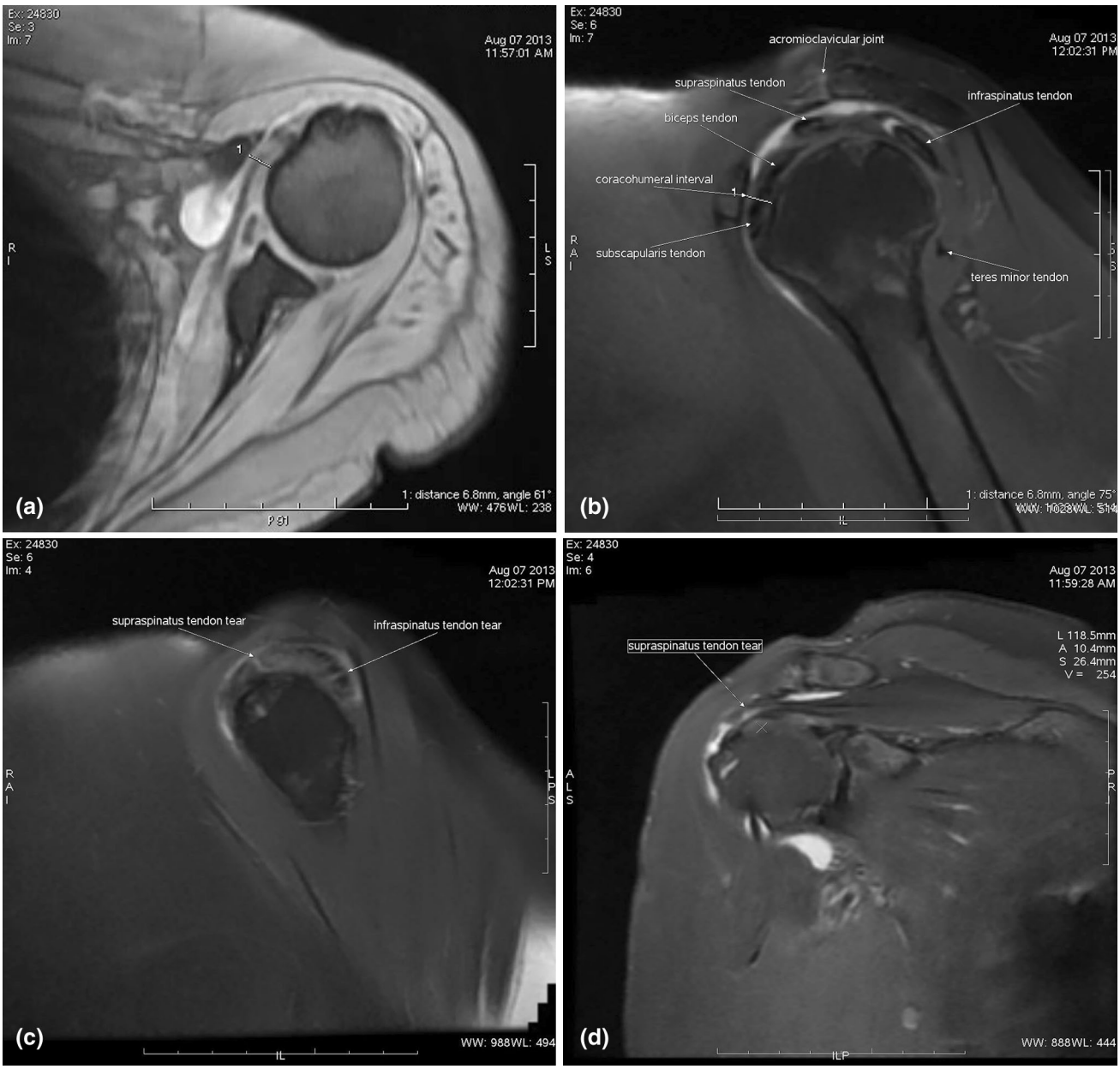

Fig. 2 The shoulder MRI of 70-year-old female patient; **a** axial gradient images showing the coracohumeral interval, which is the shortest distance between outer cortices of coracoid process and adjacent lesser tuberosity of humerus, measured as 6.8 mm. **b** Oblique sagittal proton density (PD) images showing the measurement of coracohumeral interval and the rotator cuff tendons. **c** Oblique sagittal PD images of the same patient showing the partial tear of the distal parts of the supraspinatus and infraspinatus tendons. **d** Coronal T2-weighted fat-saturated MR images showing the partial discontinuity of the supraspinatus tendon

Results

Seventy-nine of the patients were women, and 38 of them were men. The average age was 44.8 ± 14.2(14–75). The average age of the ones with a tear was 51.3 ± 12.3, and that of those without a tear was 40.0 ± 13.8.

The mean age of patients with rotator cuff tear was significantly higher than patients without tear ($p < 0.001$, $t = 4.692$). According to the Pearson correlation, there was no correlation between the age and interval values ($p = 0.131$). The mean value of CI width was 8.853 ± 2.491 mm (min: 2.9–max: 15.8). The mean interval was 8.616 ± 2.427 with the women and 9.344 ± 2.582 with the men. There were no significant differences between CI width of women and men ($p = 0.139$). The mean value of CI width with rotator cuff tear was 8.362 ± 2.382 (Fig. 2), and that without tear was 9.351 ± 2.520 (Fig. 3). There was a significant difference between them ($p = 0.031$). Table 1 shows the interval width average and standard deviation for each type of tear.

Fig. 3 The shoulder MRI of 28-year-old male patient; **a** axial gradient images showing the coracohumeral interval measured as 14 mm. **b** Oblique sagittal images showing the coracohumeral interval measured as 14.5 mm, and no rotator cuff tendon tear was detected

Table 1 Mean coracohumeral interval width and standard deviation for each type of tear

	N	Mean	SD
There is no tear	58	9,352	2,521
Partial tear of supraspinatus tendon	32	8,884	2,193
Partial tear of infraspinatus tendon	8	9,613	3,240
Partial tear of biceps tendon	3	6,667	3,308
Full-thickness tear of supraspinatus tendon	5	6,820	1,392
Full-thickness tear of supraspinatus tendon and partial tear of infraspinatus tendon	7	7,371	1,323
Tear of all rotator cuff tendons	4	6,625	1,394

There was a significant difference between all the types of tear according to one-way Anova test ($p = 0.022$) (Fig. 4)

n Number, *sd* standard deviation

Discussion

In our study, CI width decreased statistically significantly in the patients with rotator cuff tendon tear when compared to the ones without tear. However, when the patients with infraspinatus muscle tendon tear were compared with those without it, CI width appeared to be similar.

Evaluation of the CI width is performed on the MR images taken on slight internal rotation position of the shoulder. Routine shoulder MR images are taken on neutral position or slight external rotation to the shoulder. Without taking an extra sequence to our routine protocol, the image was taken on the shoulder's neutral position.

Giaroli et al. [8] reported on their assessment of the routine shoulder MR that the average CI width of 19 patients with subcoracoid impingement was 8.6 mm, while it was 9.6 mm in the control group, and they reported that in the patients group, coracohumeral interval decreased significantly. Our study was conducted on 117 patients, and CI width was found as 8.362 ± 2.382 mm in the patients group with rotator cuff tendon tear and as 9.351 ± 2.520 mm in the patients group without rotator cuff tendon tear.

Ferreira Neto et al. [9] measured the interval between the small tubercle and coracoid process as 28.4 mm at neutral position in their anatomic study, as 37.89 mm at maximum external rotation, and as 9.8 mm at maximum internal rotation. In the same study, it was determined that CI width was more reduced at maximum internal rotation in women. In our study, CI width did not show any significant difference between men and women.

Our study is the first one that shows the relationship between the CI width and rotator cuff tendons with MRI analysis. In a study by Nove-Josserand et al. [10], the relationship between the CI width and rotator cuff tendons was analyzed with CT examination. According to this study, they measured the relationship between the mean CI width as 8.4 ± 3.0 mm and it was determined that CI width had decreased in the patients with supraspinatus and subscapularis combined tears, but no difference was observed in the patients with isolated infraspinatus tendon tears. In our study, the interval width of the patients with supraspinatus partial tear was 8.8 mm and it was 6.8 mm in

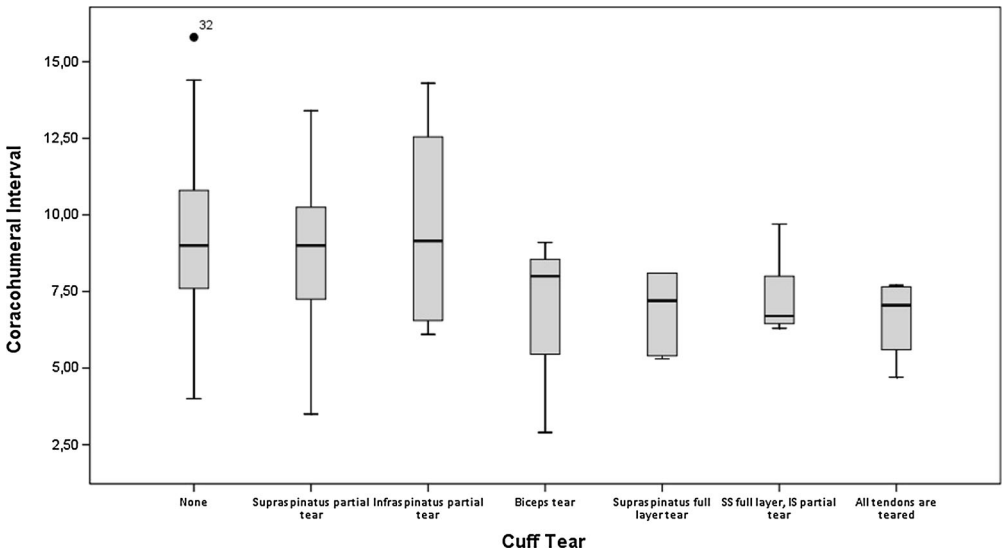

Fig. 4 There is a significant difference between all the types of tear according to one-way Anova test ($p = 0.022$)

the group with supraspinatus full-thickness tear, 6.3 mm in the group with biceps tendon tear, and 6.6 mm in all the tears of tendon. In harmony with the study by Nove-Josserand et al., there appears to be no relationship in our study between the isolated infraspinatus tendon tear and the reduced CI width.

In the anterior shoulder pain increasing with exercises, coracoid impingement should be considered in the differential diagnosis. Though coracoid impingement is not as frequent as subacromial impingement, the probability that both cases coexist should be considered before the treatment. If no improvement is seen in the symptoms in the treatments except the surgical ones, surgical decompression may be an alternative.

Moreover, if the pain goes on after the rotator cuff tendon reparation operations, the accompanying coracoid impingement should be considered [11]. The first line of treatment for coracoid impingement should be a program of activity modification, with avoidance of the provocative positions of forward flexion and medial rotation, and physical therapy to strengthen rotator cuff muscles and scapular stabilizer musculature. Surgical decompression of the subcoracoid space may be undertaken if conservative measures fail. The options include open or arthroscopic coracoplasty, a combination of coracoacromial ligament resection and acromioplasty, or anterior shoulder stabilization. In the routine MR images, evaluating the CI width may guide the surgeon before the possible surgical attempts that would be conducted for rotator cuff tendon tears.

It is well known in the literature that, the main pathognomonic feature of a rotator cuff tear is most commonly a sub-acromial impingement syndrome. On contrary, the data about coracohumeral impingement leading to a rotator cuff tear is scare and inconclusive. It is a fact that after rotator cuff tears, the humeral head could migrate anterosuperiorly, shortening the sub-acromial distance. This may also lead to a shortening of the coracohumeral interval as well. Nevertheless, to prove that, prospective controlled trials are needed in the literature analyzing the specific relationship between a cuff tear and the sub-acromial and coracohumeral intervals. In our study, we did not analyze the sub-acromial interval and only try to evaluate the relationship between coracohumeral interval and rotator cuff tears. In some of our cases, we have detected a narrowed coracohumeral interval without any rotator cuff tear. Some cases, on contrary, had normal coracohumeral interval although they had rotator cuff tears. So we believe that, although it is a hard task to define, not only the subacromial impingement syndrome, but also the coracohumeral interval width may play a role in the rotator cuff tears and this must be kept in mind while examining the patients with shoulder pain in orthopedic clinics.

Our study was conducted on static images obtained from routine MR sequences. In this way, the need to take an extra sequence for the evaluation of coracoid impingement disappeared and made a more practical evaluation possible. However, this case may be lowering the sensitivity. In addition, another limitation of our study is the evaluation, which is made over axial gradient sequences. As edge blurring increases in gradient sequences, there may be slight variations in the measurements. Taking measurements from the axial T1-weighted sequences whose edge sharpness is good may yield to better results, but it is necessary to add extra sequences to the routine drawings for this.

As a result, CI width has often decreased in the patients with rotator cuff tendon tear. The narrowing in the CI

width may be making easy the tearing of rotator cuff tendon. In the patients whose routine shoulder MRI were taken due to the shoulder ache, the decrease observed in the CI width may make one consider that rotator cuff tendons are under stress and may be evaluated as risk factor in terms of rotator cuff tear.

Conflict of interest No conflict of interest.

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