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Research Study

Magnetic Resonance Imaging of the Subcoracoid Region and Its Relationship with Subscapularis Lesions in the Chinese Population
在中國人群組中用磁力共振來評估下喙突區域及其與肩胛下肌病變的關係

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ABSTRACT

Introduction: Coracoid impingement is considered a known yet frequently overlooked cause of anterior shoulder pain. Subcoracoid stenosis has been shown to be related to subscapularis tear. Studies have shown that patients with coracoid impingement have a shorter coracohumeral distance (CHD) and a larger coracoid overlap (CO) but these are based on data from Western populations. The aim of our study was to provide a local database on the MRI measurement of these parameters in our Chinese population and raise the awareness of this disease entity.
Methods: All the shoulder MRI films taken in our hospital in 2011 were retrospectively reviewed and classified into two cohorts. The control group consisted of patients who had no subscapularis lesion. The subscapularis lesion group consisted of patients with complete tear, partial tear or abnormal signal over the subscapularis tendon. The CHD and CO were measured.
Results: We reviewed 133 sets of shoulder MRI obtained in our hospital during 2011. Thirteen patients were noted to have subscapularis lesion. The CHD in the subscapularis lesion group was 6.24 ± 2.18 mm. The CHD in the control group was 9.95 ± 3.9 mm. Women had shorter CHD (8.18 ± 2.57 mm) than men (11.0 ± 4.54 mm). We failed to notice any statistically significant difference with regards to CO, coracoid process and lesser tuberosity morphology between the two groups of patients.
Conclusion: MRI assessment of CHD can be useful in identifying patients at risk of having subscapularis lesion and coracoids impingement.

中 文 摘 要

引言: 喙突夾擠是一種已知可引起前肩關節痛，卻又時常錯過的病因。喙突狹窄已顯示與肩胛下肌撕裂有關係。有研究表明，喙突夾擠患者擁有較短的喙突肱骨距離和更大的喙突重疊，但這些都是根據來自西方人口的數據。我們研究的目的，是提供在我們中國人群組中相關磁力共振參數的測量，提高對本病的認知。
方法: 我們回顧在2011年，於我們的醫院所進行的肩膀磁力共振掃瞄進行分析，並為兩個組別。對照組包括沒有肩胛下肌病變的病人，而肩胛下病變組包括患有肩胛下肌肌腱完全撕裂，部分撕裂或掃瞄顯示異常信號的病人。我們為相關的喙突肱骨距離和喙突重疊進行了測定。
結果: 我們回顧了133套在我們醫院做的肩膀磁力共振掃瞄。 13例患者有肩胛下肌病變。肩胛下肌病變組的喙突肱骨距離是6.24±2.18毫米。對照組中的喙突肱骨距離是9.95±3.9毫米。女性擁有比男性短的喙突肱骨距離（8.18±2.57毫米 對比11.0±4.54毫米）。兩組患者之間的喙突重疊、喙突形狀和小結節形狀都沒有發現有任何統計學上顯著差異。
結論: 用肩膀磁力共振掃瞄來評定喙突肱骨距離，是有效來識別肩胛下肌病變和喙突夾擠患者的方法。

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Introduction

Coracoid impingement is a known yet uncommonly diagnosed cause of anterior shoulder pain. It is characterised by impingement of the subscapularis tendon between the coracoid process and the lesser tuberosity of the humerus. This results in tendinosis and anterior shoulder pain that is worsened by adduction, forward flexion, and internal rotation. It is an important entity to be aware of because it has been identified as a cause of persistent post-operative shoulder pain after rotator cuff repair.[1].

Recent studies have revealed a relationship between sub-coracoid stenosis, or a narrowed coracohumeral distance (CHD), as measured on magnetic resonance imaging (MRI), and subscapularis lesions.[2–6] In addition to the CHD, the coracoid overlap (CO), defined as the lateral projection of the coracoid beyond the glenoid joint line on axial computed tomography or MRI, is also reported to have an influence on the development of coracoid impingement.[7] However, most of the available data are from western populations and data from Chinese individuals are lacking in the literature. Therefore, the purpose of this study was to determine whether there is a significant relationship between a narrowed CHD and an increased CO with subscapularis lesions in the Chinese population.

Figures 1–3 illustrate a clinical case of coracoid impingement that we have recently encountered. The patient was a 26-year-old man who worked as a professional photographer. He presented with a 1-year history of right shoulder pain and weakness without any history of trauma. Physical examination revealed tenderness around the coracoid process with Grade 3 power of the subscapularis. Coracoid impingement sign (Figure 1) and lignocaine test were positive. MRI revealed signal change over the subscapularis tendon and the CHD was measured to be 6 mm (Figure 2) on axial imaging. Arthroscopic coracoplasty (Figure 3) was performed, and postoperatively, there was significant symptomatic improvement in terms of pain and function.

Materials and methods

This was a retrospective cohort study. All the MRI scans of the shoulder performed in 2011 at our institution were reviewed and classified into two cohorts. The control group consisted of patients who had no subscapularis lesion, whereas the subscapularis lesion group consisted of patients with complete tear, partial tear or abnormal signal over the subscapularis tendon. All the MRI scans were taken with the arm at the side in neutral rotation. Patients with previous fracture or surgery around the shoulder region were excluded. CHD and CO were measured. The CHD was measured as the shortest distance between the outer cortices of the coracoid process and the adjacent lesser tuberosity on axial MRI (Figure 4).[8] As for the CO, it was measured as the distance between a line drawn perpendicularly from the tangential plane of the glenoid to the most prominent tip of the coracoid on the same axial MR image (Figure 5). In addition, the morphology of the coracoid process and the lesser tuberosity was also documented. The coracoid morphology was subjectively classified into round, teardrop or oval, whereas the lesser tuberosity was classified into smooth or protuberant. If the lesser tuberosity appeared uncharacteristically large compared with the other side of the bicipital groove on the axial images, it was classified as protuberant.[6]

Specialist radiologists performed all measurements with the aid of an electronic medical imaging system, and each of these was

Figure 1. Photograph showing a 26-year-old male professional photographer. He presented with a 1-year history of right shoulder pain and weakness without any history of trauma. Physical examination revealed tenderness around the coracoid process with Grade 3 power of the subscapularis. Coracoid impingement sign and lignocaine test were positive.

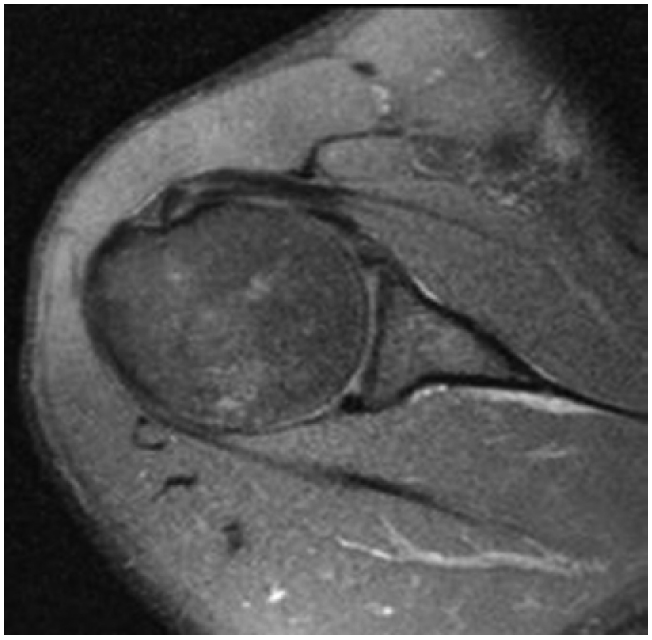

Figure 2. Magnetic resonance imaging revealed a signal change over the subscapularis tendon. The coracohumeral distance was narrow and measured 6 mm on axial imaging.

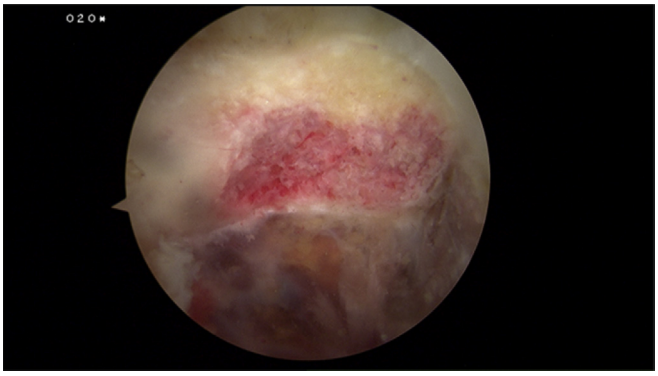

Figure 3. Arthroscopic coracoplasty was performed. Postoperatively, there was significant symptomatic improvement in terms of pain and function.

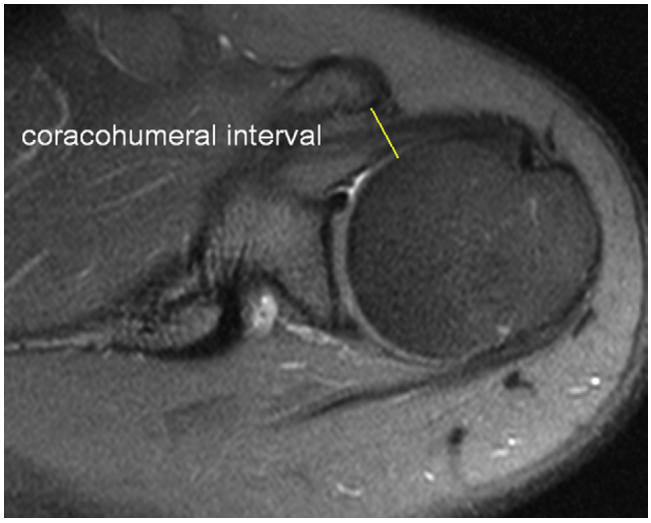

Figure 4. Coracohumeral distance was measured as the shortest distance between the outer cortices of the coracoid process and the adjacent lesser tuberosity on axial magnetic resonance imaging.

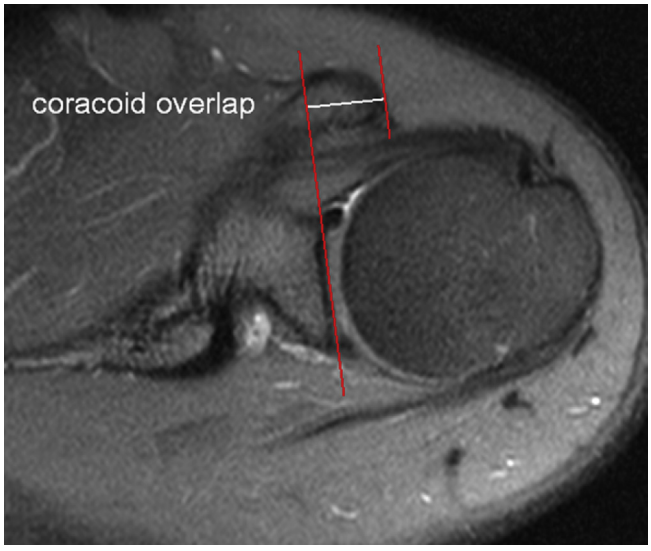

Figure 5. The coracoid overlap was measured as the distance between a line drawn perpendicularly from the tangential plane of the glenoid to the most prominent tip of the coracoid on the same axial image.

done twice to ensure accuracy. The CHD measurements of the subscapularis lesion group were compared with those of the control group. The CO, coracoid process and lesser tuberosity morphology were also compared between the two groups of patients. Comparison was also made to evaluate if there were any sexual differences among all the measured parameters.

Statistical analysis of the data was performed using Student *t* test. Statistical significance was set at $p \leq 0.05$. The data are presented as means ± standard deviation.

Results

We reviewed 133 sets of shoulder MR images obtained in our hospital during 2011. All patients were ethnic Chinese. The subscapularis lesion group consisted of 13 patients with an average age of 58.8 ± 17.6 years. Of these 13 patients, six were men and seven were women. Three cases had complete rupture of the subscapularis tendon, whereas partial rupture and abnormal signals were noted in six and four patients, respectively. One hundred and sixteen patients (120 shoulders) made up the control group with an average age of 51.6 ± 13.8 years. There were 57 men and 59 women.

Women had shorter CHD (8.18 ± 2.57 mm) than men (11.0 ± 4.54mm) ($p < 0.0001$). The CHD in the subscapularis lesion group was 6.24 ± 2.18 mm (range, 3–9 mm), whereas the CHD of the control group was 9.95 ± 3.9 mm (range, 5.4–24 mm) ($p < 0.05$). Our results showed that a narrow CHD strongly correlated with a subscapularis lesion. In contrast, there was no significant difference with regards to CO, coracoid process and lesser tuberosity morphology between the two groups of patients.

The gender-specific results of the CHD between the subscapularis lesion and control groups were analysed. The mean CHD for the male patients in the subscapularis lesion and control group was 6.61 ± 2.63 mm and 11.5 ± 4.46 mm, respectively ($p < 0.05$). For the female patients, the CHD in the subscapularis lesion and control group was 5.91 ± 1.86 mm and 8.45 ± 2.53 mm, respectively ($p < 0.05$) (Table 1).

Discussion

Goldthwait[9] described a possible rotator cuff impingement by the coracoid process in 1909. With the passage of time, coracoid impingement has been reported to be a cause of anterior shoulder pain resulting from impingement of the subscapularis tendon between the coracoid process and the lesser tuberosity of the humerus. Despite earlier studies reporting a low incidence of subscapularis tear,[10,11] a recent cadaveric study by Bennett[12] revealed that the incidence of subscapularis lesions might reach as high as 27% during arthroscopic evaluation. Suenaga et al[1] identified coracoid impingement in 11 of 216 (5.15%) cases after rotator cuff surgery due to ongoing pain and tenderness over the coracoid process. This was supported by more recent studies revealing that subcoracoid stenosis is common yet often unrecognised and under-reported.[2,13–15]

Patients with coracoid impingement have anterior shoulder pain exacerbated by forward flexion, internal rotation and adduction (e.g., the military parade rest position, throwing follow-through, driving, and writing on a blackboard).[7,16,17] This position decreases the width of the coracohumeral interval. Structures at risk of impingement include the subscapularis tendon, tendon of the long head of the biceps, and the middle glenohumeral ligament. Physical examination often reveals tenderness adjacent to the coracoid process and the coracohumeral interval. Dines et al[7] described the coracoid impingement sign, which is the painful click elicited upon passive forward flexion, adduction and internal rotation of the shoulder. The range of motion is usually preserved. Diagnostic injection of local anaesthesia into the subcoracoid region,[7,17,18] with or without image guidance, may be useful in confirming the diagnosis.

Table 1
Results of the two groups

	Control group	Subscapularis lesion group
n	116 (120 shoulders)	13
Age (y)	51.6 ± 13.8	58.8 ± 17.6
Male/female	57/59	6/7
CHD (mm)	9.95 ± 3.9	6.24 ± 2.18
CHD (male) (mm)	11.5 ± 4.46	6.61 ± 2.63
CHD (female) (mm)	8.45 ± 2.53	5.91 ± 1.86

CHD = coracohumeral distance.

The coracohumeral interval must accommodate the articular cartilage of the humeral head, joint capsule, subscapularis, and subacromial bursa, and still have enough room for the soft tissue to glide between the coracoid process and humeral head. Because of that, even minor variations in the shape and position of the coracoid tip or humeral head can jeopardise coracohumeral clearance of the rotator cuff and biceps tendon.[17] Multiple aetiologies of coracoid impingement have been described, namely, idiopathic, traumatic and iatrogenic.[16,17] Idiopathic causes include individual variations in the shape and morphology of the coracoid tip and calcification within the subscapularis tendon.[17,19,20] Ganglion cyst has also been described as one of the causes.[21] Traumatic causes include fracture of the humeral head and neck and malunion of the previous coracoid or glenoid fracture.[17] Iatrogenic causes include previous anterior shoulder surgery with coracoid transfer and posterior glenoid osteotomy.[17]

Gerber et al[22] performed an anatomical study using computed tomography to evaluate CHD in healthy patients and they found that the average value decreased from 8.7 mm to 6.8 mm with forward flexion. Coracoid impingement appeared particularly likely during forward flexion of a shoulder with a coracoid tip close to the scapular neck. Radas and Pieper[23] examined 124 cadaveric shoulders and showed that the CHD decreased significantly with internal rotation. In a cadaveric study, Ferreira Neto et al[24] also reported a significant decrease in CHD during internal rotation of the shoulder. Moreover, it has been suggested that subcoracoid stenosis is related to partial or full thickness tear of the subscapularis tendon.[2–6]

Richards et al[2] showed a significant relationship between decreased CHD and subscapularis pathology. They found an average CHD of 10 mm in patients without rotator cuff pathology and a decreased distance of 5 mm in patients with subscapularis tear. Using kinematic MRI, Friedman et al[4] found in patients with symptomatic subcoracoid impingement that CHD was an average 5.5 mm compared with 11 mm in the asymptomatic group. Giaroli et al[6] also reported similar results with significantly decreased CHD in patients with coracoid impingement. Our measurement of 6.24 mm in the subscapularis lesion group and 9.95 mm in the control group compares favourably with the previous studies. We are aware that their data were all from Caucasian-dominant populations in the United States and other European countries. To the best of our knowledge, no such relationship in the Chinese population is reported in the literature.

Friedman et al[4], Gerber et al[22] and Bonutti el al[25] reported the normal CHD to be in the range of 8.7 mm to 11 mm. The mean CHD of 9.95 mm in our control group fell within their reported normal range.

More recent studies have identified sex-based differences in CHD, with the average being 3 mm smaller in women than in men.[6,24] Our study showed a 2.82 mm difference between male and female patients in our study population.

Friedman et al[4] found that there was a higher incidence of protuberant lesser tuberosities in the symptomatic patients with coracoid impingement. Giaroli el al[6] failed to show any significant difference in the morphological assessment. However, we did not find any significant differences either in coracoid or lesser tuberosity morphology among patients with or without subscapularis lesions.

Although the association between decreased CHD and subscapularis pathology has been shown by many studies, their causal relationship is still debatable. Some investigators have suggested that decreased CHD is the consequence of cuff tear secondary to anterior shoulder subluxation, rather than the cause. Therefore, when we assess CHD, we need to look for and exclude any anterior shoulder subluxation in order to avoid false-positive measurement.

One of the main limitations of our study was our inability to recruit asymptomatic individuals with normal shoulder MRI to make up the control group, which consisted of patients with various shoulder pathologies, including glenohumeral instability and rotator cuff tear.

Conclusion

Coracoid impingement is an important yet frequently underrecognised cause of anterior shoulder pain. The challenge is to determine its presence because it often occurs concomitantly with other shoulder pathology, including subacromial impingement, rotator cuff tears and biceps pathology. Careful history taking and meticulous physical examination, together with the proper use of imaging may aid in the diagnosis.

Our study showed a significant relationship between subscapularis lesions, be it signal change, or partial or complete tear, and a narrow CHD. MRI assessment can be useful in identifying patients at risk of subscapularis lesions and coracoid impingement. However, when we assess CHD, we need to look for and exclude any anterior shoulder subluxation in order to avoid false-positive measurement.

Our results suggest that a narrow CHD, together with the corresponding clinical signs and symptoms, may alert clinicians to consider coracoid impingement as the cause of subscapularis lesions and clinical symptoms. In cases refractory to conservative management, arthroscopic treatment, including surgical decompression with coracoplasty, can achieve good results in terms of pain relief and functional improvement.

Conflicts of interest

The authors have no conflicts of interest to declare.

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