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원 저

오구돌기하 충돌 증후군 유무에 따른 초음파를 이용한 상완오구돌기 계측

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Ultrasound Measurement of Coracohumeral Distance in Patients with or without Subcoracoid Impingement

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Purpose: The purpose of this study was to evaluate coracohumeral distance (CHD) in patients with or without subcoracoid impingement with hypothesis that patients with subcoracoid impingement would have narrower CHD.
Materials and Methods: One hundred twenty-four patients with subacromial impingement were evaluated. The subjects with subcoracoid impingement which was affirmed clinically and confirmed by ultrasound guided subcoracoid injection (n=28) was compared with patients with subacromial impingement only (n=96). Patients with stiffness and rotator cuff tear were excluded. Absolute CHD was measured on magnetic resonance imaging (MRI) axial images and on ultrasound with the humerus in neutral position and internal rotation. Also relative ratio of distance difference (RRDD) defined as the difference of CHD in neutral position and internal rotation compared with absolute CHD in neutral on ultrasound was also measured.
Results: The distance measured in neutral position was similar between US imaging and MRI ($p>0.05$) and both measurements did not have significant difference between the two groups ($p>0.05$). On ultrasound, the difference in CHD in internal rotation between the two groups nearly met the level of significance ($p=0.07$). No significant difference of CHD difference in two humeral positions was seen between the two groups. However, RRDD value was significantly greater in subcoracoid impingement group ($p<0.05$).
Conclusion: No significant difference of CHD was seen between the subcoracoid impingement group and the control group. RRDD value was greater in subcoracoid impingement group suggesting that individualized coracohumeral distance in internal rotation should be taken into account when assessing patients with subcoracoid impingement.

Key Words: Shoulder, Subcoracoid impingement, Ultrasound, Coracohumeral distance

Introduction

Subcoracoid impingement has been recognized as an etiology for anterior shoulder pain for over a century. It is known to be caused by the narrowed space between the coracoid and the lesser tuberosity which in turn causes impingement of the subscapularis and the biceps tendon with movements requiring forward flexion, internal rotation, and horizontal adduction.[1-3] Many anatomical, clinical, and

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biomechanical studies have addressed the topic and have emphasized subcoracoid impingement to be relatively common, yet often unrecognized and underreported.[4-6] Accurate diagnosis is critical because wide range of treatment options from conservative management to open and arthroscopic coracoplasty can be very effective.[7] In spite of numerous studies, no standard imaging diagnostic criteria have been yet been clarified.

Plain radiography, computed tomography (CT), and magnetic resonance imaging (MRI) all have been used to evaluate coracohumeral distance (CHD).[8-11] However, standard CT and MRI allow only static evaluation of the subcoracoid space and are not practical for bilateral evaluation. Diagnositc ultrasound is a well-established tool for evaluation of rotator cuff condition and guiding therapeutic injections. We report the use of ultrasound and MRI to measure CHD in patients with subcoracoid impingement with hypothesis that patients with subcoracoid impingement would have narrower CHD.

Materials and methods

In total 275 patients who were diagnosed with impingement syndrome clinically and radiographically at the outpatient clinic at a single institute between July 2011 and March 2012 were identified. Criteria for inclusion were symptom duration of more than 3 months, no abnormalities on plain radiography, no rotator cuff tear on MRI, normal contralateral shoulder and compliance and undergoing all required sonography and tests. Exclusion criteria were stiffness or instability of shoulder, previous surgery, and inflammatory condition of shoulder including infection or calcific tendinitis.

In total 124 patients were analyzed. All patients had VAS (Visual analogue scale) score checked at initial presentation and underwent physical examination, MRI, and bilateral sonography. Depending on their clinical findings, subjects were divided into two groups: subcoracoid impingement with subacromial impingement group (SCI group) and subacromial impingement only group (SAI group).

SCI group had clinical features of subacromial impingement and positive clinical findings suggesting the diagnosis of subcoracoid impingement, which consisted of typical history of anterior shoulder pain, tenderness at coracoid process, positive coracoid impingement sign, and positive coracoid impingement test. Coracoid impingement sign was considered positive when patient reported anterior shoulder pain when the arm was in forward elevation, internal rotation and adduction.[12] Coracoid impingement test was performed by diagnostic injection with lidocaine 4 ml(2%) and triamcinolone 1 ml(40 mg/ml) in to the subcoracoid recess with ultrasound guidance. The test was considered positive if pain alleviation documented by reduction of VAS of

Fig. 1. CHD was measured on MRI axial cut which was defined as the greatest subcoracoid narrowing from coracoid cortical margin to the humeral cortical margin.

more than 30% and negative physical examination were observed when followed after 2 weeks.

The coracohumeral distance (CHD) was measured on MRI (1.5-T cylindershaped, InterAchieva; Philips, The Netherlands), which was taken with the subject's arm in neutral position. CHD was defined by greatest subcoracoid narrowing from coracoid cortical margin to the humeral cortical margin as suggested by Giaoli et al.[8] (Fig. 1). CHD was also measured on screen during the bilateral shoulder sonography. With the arm adducted and in neutral position, the CHD was measured coronally using a multifrequency linear array ultrasound transducer with a peak frequency of 13 MHz (Samsung-Medison, Seoul, Korea) 2 separate times on the symptomatic shoulder and once on the asymptomatic shoulder in each subject. The same sequence of measurements was taken with the arm adducted and internally rotated to a point when the cortical margin of the lesser tuberosity was closest to the coracoid tip (Fig. 2). After the measurements with sonography, relative ratio of distance difference (RRDD), defined as the percentage of the distance difference in neutral and in internal rotation compared with distance in neutral, was also calculated. This method was used to standardize the relative amount of distance difference in internal rotation to the individually different coracohumeral distance (Fig. 2).

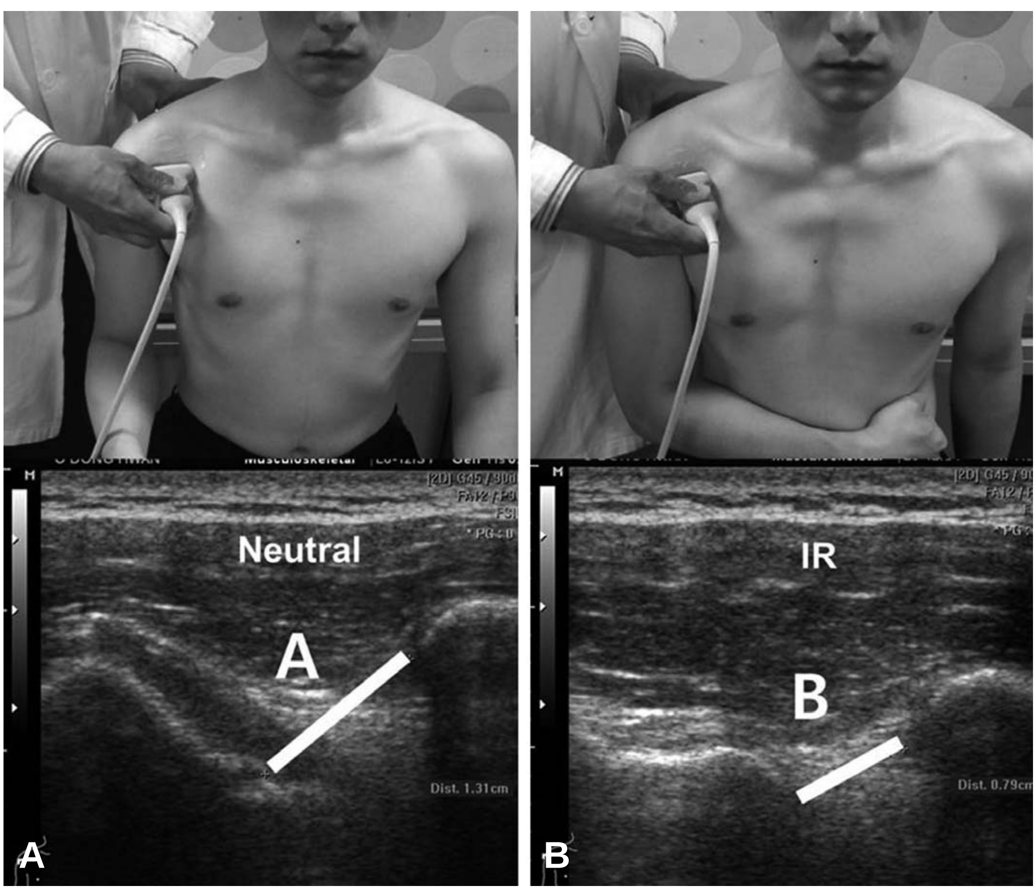

Fig. 2. (**A**) CHD was measured coronally with the arm adducted and in neutral position from the cortical margin of the lesser tuberosity to the cortical margin of the coracoid tip. (**B**) The same measurements was taken with the arm adducted and internally rotated to a point when the lesser tuberosity was closest to the coracoid tip. Relative ratio of distance difference (RRDD) is defined as the percentage of the distance difference in neutral and in internal rotation compared with distance in neutral. (RRDD=(A-B)/A$\times$100).

SPSS software (version 18.0 for Windows; SPSS Chicago, IL, USA) was used for statistical analyses. Student's t test was used to compare the CHD between SCI group and SAI group and other variables. The nonparametric data were evaluated with the χ^2 test. Significance was defined as $p<0.05$

Results

In total 28 (22%) subjects had all the clinical features of subcoracoid impingement, including positive coracoid impingement test (SCI group) and 96 (78%) had only subacromial impingement symptoms (SAI group). There was no significant difference in side of involvement, mean age, sex distribution, VAS at initial presentation and symptom duration (Table 1). The intraclass correlation coefficients for the intraobserver reliability of sonographic CHD measurements in neutral and in internal rotation were in excellent rage with 0.85 and 0.81, respectively. In all subjects, there were no significant difference in the mean CHD between involved and uninvolved shoulder in neutral (p=0.55) or internal rotation (p=0.47). No significant difference of mean CHD in neutral was seen between the measurements on MRI and ultrasound (Table 2).

The difference of mean CHD in neutral position was not significant on MRI nor on ultrasound. The difference of mean CHD in internal rotation in SCI group (0.50±0.13) and SAI group (0.56±0.21) on ultrasound nearly met the level of significance (p=0.071). There was no significant difference between the two groups regarding the measurement difference in neutral and internal rotation (p=0.886). However, the RRDD, which was used to standardize the amount of CHD difference in neutral and internal rotation to the different CHD's among individuals, was 49.8%±9.5% in SCI

Table 1. Demographic data and comparison of clinical presentation between SCI and SAI group

	SCI group (n)	SAI group (n)	*p* value
Number (n=124)	28 (22%)	96 (78%)	-
Affected side			0.52
Dominant	14	56	
Non-dominant	14	56	
Age (years)			0.99
Range	33-69	21-71	
Mean	53.5	52.6	
Sex distribution			1.00
Male	15	53	
Female	13	43	
Symptom duration (months)*	10.2±6.1	9.7±7.7	0.662
VAS (at rest)*	1.5±2.2	1.1±1.2	0.452
VAS (at ROM)*	5.8±1.3	5.5±0.9	0.752

* Mean±SD
SCI: subcoracoid impingement with subacromial impingement, SAI: subacromial impingement only

Table 2. Comparison of CHD in neutral position between MRI and ultrasonogrphy (US)

	MRI.	US	*p* value	95% confidence interval
CHD*	0.94±0.21	0.95±0.22	0.917	-0.16, 0.14

* Mean±SD
CHD: coracohumeral distance

group and 34.5%±10.8% in SAI group and differed significantly (p=0.007) (Table 3).

Discussion

We hypothesized that patients with subcoracoid impingement would have narrower CHD. Our study used dynamic ultrasonography, measuring CHD in two positions, and showed that although there was significant difference in RRDD between the two groups, the absolute CHD in neutral or in internal rotation did not differ significantly between the two groups. This implies that individualized amount of difference of coracohumeral interval during internal rotation, which is one of the key motions to elicit subcoracoid impingement, may be associated with the symptoms.

Most authors agree that diagnosis of subcoracoid impingement is a mainly clinical one. Gerber et al.[2] described subcoracoid impingement as dull anterior shoulder pain aggravated by forward flexion and internal rotation. Physical examination of affected patients show tenderness at the coracoid tip and reproduction of pain with the arm internally rotated at 90° abduction or adducted with 90° of shoulder flexion. Many authors assert subcoracoid stenosis to be relatively common.[4,5] Isolated subcoracoid impingement is very uncommon and incidence has been reported to be 2.8% to 19%.[3,13,14] To overcome the small number of subjects, we enrolled patients with subacromial impingement without rotator cuff tear or stiffness and divided them into two groups depending on whether they had subcoracoid impingement. Our study showed that incidence of subcoracoid impingement to be 23% of patients with subacromial impingement in our study cohort.

With the advent of arthroscopic coracoplasty and many studies showing promising results,[7,15] determining proper candidates for such surgery has become crucial. Although there are many studies investigating the relation between the coracoid and the humerus, the role of imaging in diagnosis of subcoracoid impingement is still controversial. Standard radiographs may show far laterally projecting coracoid process in the anteroposterior view or in the suprapinatus outlet view. Kragh et al.[16] identified a chevron-shaped coracoacromial outlet in patients with primary subcoracoid impingement. There also may be sex-based difference in the average coracohumeral interval, with females having a space measuring 3 mm smaller than that in males.[8] Bonutti et al.[17] described and abnormal CHD to be less than 11 mm on MRIs in patient with shoulder pain. Richards et al.[18] reported on the narrowed CHD in patients with tears of the subscapularis. They found an average coracohumeral distance of 10 mm in patients without rotator cuff pathology and a decreased distance of 5 mm in

Table 3. Comparison of CHD between SCI and SAI group

	SCI group (n=28)	SAI group (n=96)	*p* value
CHD on MRI (cm)	0.96±0.20	0.94±0.22	0.625
CHD on ultrasonography			
Neutral	0.92±0.21	0.86±0.23	0.679
Internal rotation (IR)	0.50±0.13	0.56±0.21	0.071
Neutral-IR difference	0.42±0.16	0.30±0.19	0.886
RRDD (%)	49.8±9.5	34.5±10.8	0.007*

* p<0.05
CHD: coracohumeral distance, SCI: subcoracoid impingement with subacromial impingement, SAI: subacromial impingement only, RRDD: relative ratio of distance difference

patients with subscapularis tears. MRI examination was found to 5.3% sensitive yet 97% specific for subcoracoid impingement.[8)]

Several studies have shown that coracohumeral interval decreases with shoulder position. Gerber et al.[10)] used CT to evaluate the coracohumeral interval in healthy patients. They found that the average value of 8.7 mm decreased to 6.8 mm with forward flexion. Friedman et al.[11)] used dynamic MRI to evaluate the coracohumeral interval, and asymptomatic volunteers showed coracohumeral interval of 11 mm in maximum internal rotation, whereas symptomatic patients showed 5.5 mm. However these techniques are not widely available and cumbersome and it is not a cost-effective diagnostic option.

Ultrasonography can be an easily available, dependable method to evaluate the relation between the coracoid and humerus and diagnose subcoracoid impingement. Also dynamic real-time evaluation of the subcoracoid recess thereby overcoming static evaluation obtained by CT or MRI as well as concomitant usage of treatment by delivering injections to the affected sites makes sonography more beneficial.

Ultrasonograhy for diagnosis of subcoracoid impingement has been reported in one single study in the literature, showing a narrowed CHD in patients with clinically diagnosed subcoracoid impingement (n=8).[19)] However, sonographic measurement was done statically in one single position on a small number of patients without comparison with MRI.

To our knowledge, no study has examined subcoracoid impingement dynamically with ultrasonography. We ruled out other possible shoulder pathologies with MRI and also the CHD in neutral was compared. This study had several limitations. The SCI and SAI groups were not matched for age, sex, or BMI. We have not taken into account of the soft tissue thickening on the anteroinferior aspect of the coracoid tip representing the fibrous falx as demonstrated by Dumontier et al.[3)], which can be a potential source of impingement. We have grouped patients according to their findings during clinical examination. However, the clinical examination is subjective by nature, and validity of subcoracoid physical tests has not yet been reported. Also although the effectiveness of the steroid mixed with local anesthetic injection provides evidence for the accuracy of our clinical diagnosis of subcoracoid impingement, it may as well been effective on symptoms related to other shoulder pathologies, thus confusing the diagnosis. Future studies are needed to prove the reliability and validity of our procedure.

Conclusion

No significant difference of CHD was seen between the subcoracoid impingement group and the control group. RRDD value was greater in subcoracoid impingement group suggesting that individualized coracohumeral distance in internal rotation should be taken into account when assessing patients with subcoracoid impingement.

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국문초록

목적: 오구돌기하 충돌증후군은 전방 견관절 통증의 원인 중 하나로 알려져 있지만, 현재까지 표준이 되는 영상학적 진단 기준이 없다. 본 연구는 오구돌기하 충돌증후군이 있는 환자군에서 상완-오구돌기간의 거리(CHD)가 좁을 것이라는 가정하에, 오구돌기하 충돌증후군 유무에 따른 상완-오구돌기간 거리를 분석하였다.
대상 및 방법: 견봉하 충돌증후군 환자 124명을 분석하였다. 이학적 검사 및 초음파를 이용한 오구돌기하 주사 검사를 통하여 확진 된 오구돌기하 충돌증후군의 환자군(n=28)을 견봉하 충돌증후군만 있는 군(n=96)과 비교하였다. 견관절의 강직이나, 회전근개 파열이 있는 환자는 대상에서 제외되었다. 상완-오구돌기간의 절대적 거리는 초음파의 내회전과 중립위 자세 및 자기공명 횡단면 영상에서 측정하였다. 또한 내회전과 중립위의 상완-오구돌기간 거리의 차이와, 중립위의 상완-오구돌기간 절대적 거리와의 비율로 정의된 거리 차이의 상대적 비율(relative ratio of distance difference; RRDD)도 함께 측정하였다.
결과: 중립위의 거리는 초음파 영상과 자기공명영상에서 비슷한 값을 보였고($p>0.05$), 두 측정값의 두 군간에 유의한 차이는 없었다($p>0.05$). 초음파영상을 통해 측정한 두 군간의 중립위 거리 차이는 유의수준에 가까웠다($p=0.07$). 상완의 위치에 따른 상완-오구돌기간 거리의 차이는 두 군간에 통계학적 유의성이 없었다. 하지만, RRDD 값은 오구돌기하 충돌증후군 환자군에서 유의하게 더 컸다($p<0.05$).
결론: 오구돌기하 충돌 증후군 환자군과 대조군 사이의 상완-오구돌기간 거리 차이의 유의한 차이가 없었다. RRDD값은 오구돌기하 충돌 증후군 환자군에서 더 높았으며, 따라서 오구돌기하 충돌증후군이 있는 환자를 평가할 때 개인의 내회전시 상완-오구돌기간 상대적 거리도 함께 고려해야 한다.

색인단어: 견관절, 오구돌기하 충돌, 초음파, 상완-오구돌기간 거리