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ARAŞTIRMA YAZISI / RESEARCH ARTICLE

SUPRASPINATUS TENDİNİTİ VE SKAPULA MORFOMETRİK PARAMETRELERİ ARASINDAKİ İLİŞKİ

THE RELATIONSHIP BETWEEN THE MORPHOMETRIC PARAMETERS OF SCAPULA AND SUPRASPINATUS TENDINITIS

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ÖZ

AMAÇ: Tendinit en sık görülen omuz lezyonlarından biridir. Bu çalışmanın amacı, kritik omuz açısı (KOA), glenoid eğimi (GI) ve akromiyon indeksi (AI) dahil olmak üzere radyolojik parametrelerin supraspinatus tendiniti ile korelasyonunu değerlendirmektir.

GEREÇ VE YÖNTEM: Çalışmaya 72 hasta (47 erkek, 27 kadın, yaş ortalaması 29 ± 5.2 (18-40)) dahil edildi. Omuz manyetik rezonans görüntüleri ;supraspinatus tendonundaki sinyal artışına göre normal olan Grup I (n = 33) ve yüksek olan Grup II (n = 41) olmak üzere iki gruba ayrıldı.Nötral pozisyonda elde edilen omuz radyografilerinde kritik omuz açısı, glenoid eğim ve akromiyon indeksiparametreleri ölçüldü. Radyolojik parametreler ile supraspinatus tendinit varlığı arasındaki ilişki değerlendirildi.

BULGULAR: Grup I'de Ortalama KOA 37.9°, ortalama GI 17.2° ve ortalama AI 0.8 idi. Grup II'de Ortalama KOA 38.3°, ortalama GI 17.1° ve ortalama AI 0.8 idi. Gruplar arasında istatistiksel olarak anlamlı bir fark bulunmadı. Kadınların KOA değerleri erkeklerden istatistiksel olarak anlamlı derecede yüksekti (p = 0.04).

SONUÇ: Yüksek KOA değerlerinin rotator manşet yırtığı ve düşük KOA değerlerinin osteoartrit ile ilişkili olduğu bulunmuştur. Çalışmamızda supraspinatus tendinit ile KOA, AI ve GI parametreleri arasında ilişki saptamadık. Supraspinatusun erken tanısında kullanılmak üzere yeni morfometrik parametrelere ihtiyaç vardır.

ANAHTAR KELİMELER: Tendinit; Kritik omuz açısı; Glenoid eğim; Akromiyon indeksi

ABSTRACT

OBJECTIVE: Tendinitis is one of the most frequent shoulder lesions. The aim of this study is to evaluate the correlation of the radiological parameters including critical shoulder angle (CSA), glenoid inclination (GI) and acromion index (AI) with supraspinatus tendinitis.

MATERIAL AND METHODS: Seventy-four patients (47 men, 27 women, mean age 29±5.2 (range 18-40)) were included in the study. Two groups were formed as Group I (n=33) and Group II (n=41) according to supraspinatus tendon intensity revealed by shoulder magnetic resonance images. Critical shoulder angle, glenoid inclination and acromion index parameters were measured on shoulder radiographs obtained in neutral position. The relationship of the radiologic parameters and the presence of supraspinatus tendinitis were evaluated.

RESULTS: The mean CSA was 37.9°, the mean GI was 17.2°, and the mean AI was 0.8 in Group I. The mean CSA was 38.3°, the mean GI was 17.1°, and the mean AI was 0.8 in Group II. No statistically significant difference was found between the groups. The CSA values of the women were statistically significantly higher than that of the men (p=0.04).

CONCLUSIONS: Higher CSA values are found to be associated with the risk of rotator cuff tear and lower CSA values with osteoarthritis. Higher angles are associated with increased risk of supraspinatus tendinitis tear. Supraspinatus tendinitis is not associated with the morphometric parameters including CSA, AI and GI. New morphometric parameters should be identified and their relation with supraspinatus tendinitis should be investigated for early diagnosis.

KEYWORDS: Tendinitis; Critical shoulder angle; Glenoid inclination; Acromion index

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INTRODUCTION

Rotator cuff is one of the primary stabilizers of the glenohumeral joint, as it stabilizes the humeral head within the glenoid and prevents the upwards translation of the humeral head. (1). It is well known that the rotator cuff lesions result from a combination of intrinsic (genetic) and extrinsic (anatomical) risk factors (2). Several extrinsic factors have been proposed in the development of rotator cuff tears (RCT) and glenohumeral osteoarthritis including anterior acromion morphology, lateral acromion angle, coracohumeral interval, glenoid inclination (GI), and most recently acromion index (AI) (3,9).

There are various studies reporting the relationship between the biomechanical factors related to anatomical morphology of scapula and RCT. Recent studies determined that the lateral extension of acromion and upward inclination of glenoid were related to RCT (5, 6). Moor defined the critical shoulder angle (CSA) by using these two anatomic factors. (10). The studies carried out with biomechanical modeling demonstrated that higher CSA reduced the glenohumeral stability and the load on the supraspinatus (SSP) increased to ensure the stabilization of the arm during active abduction (11,14). The other two parameters used to assess the scapular morphology are GI and AI. Increased upwards tilt of glenoid increases the RCT risk. The increased retroversion of glenoid is associated with anterior cuff tear, and its increased anteversion is associated with posterior cuff tear (11,15). Nyffeler claimed that high AI increased vertical vectorial force on the central fibrils of deltoid, pulled the humeral head upwards and there was more load on the SSP attempting to prevent this pull during active abduction (9).

Rotator cuff lesion is a process beginning with inflammation in the tendon and progressing to the tear. The first pathological change altering the normal morphology of the rotator sheath is tendinitis. This change is mostly observed in the supraspinatus tendon. The early diagnosis of rotator sheath lesions not only facilitates the treatment, but also improves patient's unfavorable life quality resulting from the increasing limitation of movement due to pain (2, 16, 17). The impact of the radiologic parameters on outcomes after SSP has not been investigated previously.

The aim of this study was to assess the relationship between the radiologic parameters and SSP tendinitis as these parameters may be helpful during diagnostic evaluation of the patients with shoulder pain and can help predict the pathology.

MATERIALS AND METHOD

The medical records of the patients who had applied to our institution with the complaint of shoulder pain between the years 2015 and 2017 were retrospectively evaluated. The inclusion criteria were being in 18 and 40 years age group, to be evaluated with a true anterior-posterior (AP) radiograph of the shoulders, obtained with the central X-ray beam parallel to the glenoid fossa, revealing a clear joint space and only minimal overhang between the anterior and posterior glenoid rim, and also being evaluated with a magnetic resonance (MR) imaging. A total of 74 shoulders fulfilled the inclusion criteria. The patients with a diagnosis of disorders including inflammatory arthritis, adhesive capsulitis, rotator cuff tears, shoulder impingement syndrome, Superior Labrum Anterior and Posterior (SLAP) injury, Bankart or Hill-Sacks lesions, previous history of shoulder trauma, fractures, shoulder operations and shoulder dislocation were excluded from the study.

MR imaging studies of the shoulder were performed on a 1.5 Tesla magnet (Signa Excite HDx, GE Medical Systems, and Waukesha, WI, USA) using and 8-channel dedicated shoulder coil, with the arm positioned in neutral rotation by the patient's side. All MR images were evaluated by an experienced musculoskeletal radiologist. The rotator cuff was evaluated through oblique coronal, oblique sagittal, and transverse T2-weighted and proton-density-weighted images, as well as on short tau inversion recovery sequences, according to established magnetic resonance imaging (MRI) criteria (18). According to MR images the patients were divided in two groups. Group I consisted of the patients with normal signal intensity of the rotator cuff tendons on MRI and Group II consisted of high signal intensity of the rotator cuff tendons as revealed by MRI.

Radiologic parameters including CSA, AI and GI were evaluated on radiographs. All measurements were carried out electronically on the anterior-posterior shoulder radiographs obtained in neutral position by a single researcher using the Infinity PACS (Infinity Healthcare Co., Seoul, South Korea) system. CSA was measured to be the angle between the line connecting the upper and lower bone boundaries of the glenoid and the line connecting the outmost edge of the acromion and the lower bone boundary of the glenoid (10).

Three parallel lines were used in the measurement of AI. The first one was the line connecting the upper and lower edges of the glenoid, the second one is the tangent passing over the lateral edge of the acromion, and the third one is the tangent passing over the most proximal edge of the humerus. The ratio of the distance between lines 1 and 2 to the distance between lines 3 and 4 was measured (9).

GI was the β angle between supraspinatus cavity base and the line connecting the upper and lower edges of the glenoid. Supraspinatus cavity base is observed as a sclerotic line on the neutral anterior-posterior shoulder graphs. GI is calculated by subtracting the β angle from 90° **(Figure 1, 2, 3)** (3).

Figure 1: CSA is the angle between glenoid and lateral border of the acromion figüre

Figure 2: The acromion index (AI) was calculated by dividing the distance from the glenoid plane to the acromion by the distance from the glenoid plane to the lateral aspect of the humeral head

Figure 3: GI is the angle between the floor of the supraspinatus fossa and the glenoid fossa line.

ETHICS APPROVAL

This study was approved by the Ethical Committee in Metin Sabanci Baltalimani Bone Diseases Education and Research Hospital, Turkey.

STATISTICAL ANALYSIS

The Statistical Package version 17.0 (SPSS) was used (SPSS, Chicago, Illinois). Normality of data in each group was analyzed, in order to define the type of comparison test to be used. t-test was utilized to compare the means when the distribution was normal; Mann–Whitney test was employed when normal distribution was not observed. Descriptive analysis was performed to report means and standard deviations (SDs), as well as the ranges of the data. Fisher's exact test was performed to compare categorical variables and the Mann–Whitney rank-sum test to compare continuous variables. Pearson's correlation analysis (R) was used for comparison of measured values and the associated age. Statistical significance was defined as $p < 0.05$.

RESULTS

Mean age was similar in both groups. The average age was 29±5.2 in Group 1, whereas it was 30±5.2 in Group 2 **(Table 1)**.

Table 1: Demographic distribution of the patients in group

	Group I (normal signal)	Group II (high signal)	Total
n	33(45%)	41(55%)	74
Women	9 (27,2%)	18 (43,9%)	27 36,4%)
Men	24 (72,7%)	23 (56%)	47(63,5%)
Age mean yrs	29 (18-39)	30,7 (21-39)	

In Group 1 the mean CSA, GI and AI were found as 37.9±5.9º, 17.2±8.6 and0, 8±0.1 respectively. In Group 2 the mean CSA, GI and AI were found as 38.3±5.1, 17.1±6.7 and 0.8±0.1 respectively **(Table 2)**. There was no statistically significant difference between the groups regarding CSA, GI and AI.

Table 2: The results of the radiographic parameter in both groups

	N	Mean CSA± SD(degrees°)	Mean GI± SD	Mean AI± SD
Group 1	33	37,9±5,9	17,2±8,6	0,8±0,1
Group 2	41	38,3±5,1	17,1±6,7	0,8±0,1
p		0,72	0,94	0,26

The CSA angle values were statistically higher in women (p= 0.04). There was no statistically significant difference in other parameters **(Table 3)**.

Table 3: The results of the radiographic parameter according to the gender. *Mann whitney –U

		MeanCSA± SD	MeanGI± SD	MeanAI± SD
Women	27	39,9±6	15,1±8,6	0,8 ± 0,1
Men	47	37,1 ± 4,9	18,3 ± 6,8	0,7 ± 0,1
*pValue		*0,04*	0,21	0,25

There was no statistical correlation considering the relationship between the age and the radiographic parameters. **(Table 4).**

Table 4: Correlation between age and angles * r: correlation coefficient from pearson testCorrelation is significant at the 0.01 level

		CSA	GI	AI
Age	*r	-0,166	-0,053	-0,052
	p	0,157	0,653	0,66

DISCUSSION

In our study, we asserted that the angles could be used for early diagnosis purposes in RCT. However, we did not determine any significant difference between the normal group and the tendinitis groups. While there are various studies in the literature which assess the relationship between the RCT and osteoarthritis by means of new measurement methods specified in the scapular morphology, There is no study assessing the relationship between the scapular morphology and SSP tendinitis. Moreover, there are no normal value ranges set forth concerning these angles. This leads to errors when comparing to the studies in the literature.

There are more studies about the newly defined CSA than the studies about GI and AI. Moor et al. evaluated the predictive value of age and CSA on RCT. They asserted that larger CSA (>35°) is the most accurate radiographic predictor for the development of RCT. Also smaller CSA (<30°) was found to be associated with glenohumeral osteoarthritis. They claimed that the CSA is the most accurate radiographic predictor for the development of atraumatic RCT (10). Bjarnison et al claimed that in their study the mean CSA was 33.9° in the RCT group and 33.6° in the matched control group. They did not find any association between CSA and RCT (19).There is also different result from various other studies (10, 15, 20-23) **(Table 5)**.

Table 5: Different result from various other studies

n-age mean	RCT	CONTROL	
n=279 - 58	38° (84%)	33.1°	Moor et al.,2013
n=10-52,7	37.3°(79%)	32.7°	Spiegl et al.,2016
n=50-72,9	37.9°		Daggett et al,2015
n=28-55	36.4°		L.Cherchietal.,2016
n=78-59,9	39.7°(65%)	33.5°	Gomide et al,2017
n=103-	39.4°(68%)	37.4°	Miswan et al,2017
n=74-30,7	38,3(55%)	37,9	Our study

In another study CSA was determined to be 34°±3° in the control group, 36°±3° in the isolated SSP tear group. In the same study, they accepted 35° as the limit value for the CSA measurement sensitively by 53% and specifically by 74%. (24). In our study, we measured it as CSA 37.9°±5.9° in the control group and as 38.3°±5.1° in the tendinitis group. We did not detect any relationship between the CSA angles and tendinitis (p=0.72).

The SSP was the most sensitive muscle to the 2 anatomic parameters. As expected, GI had a smaller effect on SSP forces than AI and consequently on glenohumeral joint forces. Increasing AI increased the deltoid moment arm, thus reducing its required force, as well as the stabilizing effect of the SSP. Consequently, a higher AI was associated with a lower and less compressive joint force, as already suggested (9, 10). We used these 2 parameters in our study, as well. Recently, higher values of the AI in patients with RCT as compared to patients without rotator cuff pathology (6, 9, 25). Is an angle which indicates the lateral acromial extension amount. It was shown to have a close relationship with RCT (6). The AI of asymptomatic shoulder with intact rotator cuff was 0.64 ± 0.06, AI value in full thickness RCT (0.73 ± 0.06) were higher than AI value in osteoarthritis (0.60±0.08) (23). We found the AI as 0.8± 0.1 in the control group and tendinitis group (0.8±0.1). However; we could not determine any statistically statistical relationship between tendinitis and AI. Similar to our study, no relationship was found between the AI and RCT in the literature (26).

Hughes et al. also showed that a higher upward force could be caused by an increased inclination of the glenoid, leading to a reduced ability of the glenoid to resist the deltoid contraction force (5). In support of this theory, the authors found significant increases in GI in eight cadaveric specimens with RCT compared to the uninjured contralateral side. Both theories of an increased upward force of the humeral head are logical from a biomechanical point of view, leading to the assumption that both theories may play roles in the pathogenesis of RCT. In our study, we measured the GI as 17.2±8.6 in the control group and as 17.1 ±6.7 in the tendinitis group. We did not determine any significant difference between the groups (p=0.94). Different GI angles were determined in the previous studies. Hughes et al reported a difference in GI of 7.6, whereas Tetreault et al reported a difference in GI of 10 (27).

The AI and the GI models share the same biomechanical theories on the pathogenesis of RCT (6,9). AI classification RCT:0.73±0.06; glenohumeral osteoarthritis: 0.60±0.08; normal shoulders: 0.64±0.06. But, Gu et al.found no association between a low acromion AI and glenohumeral osteoarthritis (28). Christoph et al. evaluated the relationship of GI and AI with SSP tear. The modeling made on the MRI sections taken from an asymptomatic volunteer aged 27 years was used. Glenoid joint surface cartilage damage was determined to have a positive correlation with GI and a negative correlation with AI. A weak negative correlation with CSA was obtained. In this model, it seems that CSA may be better than GI and AI for tendon tear risk, but it is less important than GI and AI for OA risk. AI is more effective than GI on supraspinatus force. Increased AI increases the effort arm of the deltoid, and the load of the supraspinatus increases for stabilization, and the high AI leads to a decrease in the load and compression on the joint (29). In our study, we measured the GI as 17.2±8.6 in the control group and as 17.1±6.7 in the tendinitis group. We did not determine any statistically significant relationship between GI and tendinitis.

Cherchia et al. could not find any difference between CSA according to the gender (15). However, in our study the mean CSA was higher (39.9°) in women than that of men (37.1°) and this difference was statistically significant (p=0.04). Similar to our study, women individuals presented with larger mean CSA 37.1° (men: 35.6°) and AI 0.77 (men0.71) than men individuals in the South African population (30).

The weaknesses of the study include being retrospective and conducting the assessment once the angle measurements that are subjective criteria. The normal reference range concerning these angles is not clear in the literature. It could be included in the MR results of asymptomatic as a different group. However, performing MR studies in asymptomatic individuals is challenging. While patients' neutral plane X-rays were available, the scapular rotation that might have changed minimally was not eliminated. Majority of the studies examined the advanced age groups (40-60 years) and mostly the joint degeneration was assessed. We included a younger age group in our study because we aimed to reveal how the measurements were affected by the changes in the early stage (age mean 30±5.2).

Different shoulder biomechanics resulting from variations in scapular anatomy may be an intrinsic risk factor for rotator cuff disorders. Static and 2-dimensional assessment methods may yield insufficient results when trying to examine the shoulder joint which is a dynamic and 3-dimensional structure.

We did not determine any relationship between the SSP tendinitis and CSA, AI and GI. We postulate that changes may occur during the process from tendinitis to tear formation. Prospective and randomized controlled studies including more patients are needed to reveal such differences. Further investigation is necessary to elucidate the relationship between individual scapular anatomy and rotator cuff disease.

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