Bir Türk Kohortunda Dejeneratif Rotator Kaf Yırtıklarının Radiografik Öngörücü Faktörleri

Radiographic Predictive Factors of Degenerative Rotator Cuff Tears in a Turkish Cohort

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ÖZ

GİRİŞ ve AMAÇ: *Kritik omuz açısı (CSA), lateral akromiyal açı (LAA) ve akromiyon indeksi (AI), rotator manşet yırtığı (RCT) olan hastalar ile sağlam rotator manşeti olan hastalar arasında ayrım yapmak için kullanılan yaygın radyolojik parametrelerdir. Bu çalışma, dejeneratif RCT'de bu parametrelerin tahmin gücünü değerlendirmeyi amaçlamaktadır.*

YÖNTEM ve GEREÇLER: *Bu retrospektif çalışma, iki gruba ayrılan 92 hastadan alınan verileri içeriyordu: 47 dejeneratif tam kat supraspinatus tendon yırtığı olan 47 hastayı içeren RCT grubu ve yırtığı olmayan 45 kişiden oluşan bir kontrol grubu. Standartlaştırılmış gerçek ön-arka radyografilerden CSA, AI ve LAA ölçümleri bağımsız olarak iki ortopedi cerrahı tarafından türetilmiş ve analiz edilmiştir. Kesme değerlerini belirlemek için alıcı çalışma karakteristiği (ROC) analizleri yapılmıştır.*

BULGULAR: *RCT ve kontrol gruplarındaki hastalar arasında yaş (p = 0.079), cinsiyet (p = 0.804) veya yaralanma tarafı (p = 0.552) açısından anlamlı farklılık bulunmadı. CSA, LAA ve AI değerleri için mükemmel gözlemciler arası güvenilirlik görüldü. Ortalama CSA (38.1°) ve AI (0.72) değerleri RCT grubunda kontrol grubuna göre anlamlı olarak daha yüksekti ve LAA için gruplar arasında anlamlı bir fark yoktu. ROC analizi, 37.95 ° kesme değeriyle CSA için 0.815'lik eğri altında bir alan (AUC) verdi ve CSA'nın RCT varlığının en güçlü öngörücüsü olduğu bulundu*

TARTIŞMA ve SONUÇ: *CSA ve AI, Türk popülasyonunda dejeneratif RCT için yararlı prediktif faktörler olabilir.*

Anahtar Kelimeler: *kritik omuz açısı, rotator kaf, akromiyal indeks, akromiyon, lateral akromiyal açı*

ABSTRACT

INTRODUCTION: *Critical shoulder angle (CSA), lateral acromial angle (LAA), and acromion index (AI) are common radiologic parameters used to distinguish between patients with rotator cuff tears (RCT) and those with an intact rotator cuff. This study aims to assess the predictive power of these parameters in degenerative RCT.*

METHODS: *This retrospective study included data from 92 patients who were divided into two groups: the RCT group, which included 47 patients with degenerative full-thickness supraspinatus tendon tears, and a control group of 45 subjects without tears. CSA, AI, and LAA measurements from standardized true anteroposterior radiographs were independently derived and analyzed by two orthopedic surgeons. To determine the cutoff values, receiver operating characteristic (ROC) analyses were performed.*

RESULTS: *No significant differences were found between patients in the RCT and control groups in age (p = 0.079), gender (p = 0.804), or injury side (p = 0.552). Excellent inter-observer reliability was seen for CSA, LAA, and AI values. Mean CSA (38.1°) and AI (0.72) values were significantly larger in the RCT group than in the control group with no significant difference between groups for LAA. ROC analysis yielded an area under the curve (AUC) of 0.815 for CSA with a cutoff value of 37.95°, and CSA was found to be the strongest predictor of the presence of a RCT.*

DISCUSSION AND CONCLUSION: *CSA and AI may be useful predictive factors for degenerative RCT in the Turkish population.*

Keywords: *critical shoulder angle, rotator cuff, acromion index, acromion, lateral acromial angle*

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INTRODUCTION

One of the most common shoulder pathologies is degenerative rotator cuff tear (RCT) (1). However, the pathogenesis of degenerative RCT is not clearly understood and has been attributed to many factors, categorized by some authors as intrinsic and extrinsic (2, 3). The most important intrinsic factors are tissue degeneration or poor local vascularization, oxidative stress-related change, and aging (4), while some studies have reported acromion morphology, specifically the type of acromion, the lateral extension of the acromion (acromion index [AI]), the lateral acromion angle (LAA), and the critical shoulder angle (CSA) as important extrinsic risk factors leading to the development of degenerative RCT (5–8).

Lateral extension of the acromion is described by the AI value, and a high AI value corresponds to a large lateral extension of the acromion. Importantly, some studies have showed an association between high AI values and full-thickness RCT significantly (8, 9). The LAA reflects glenoid inclination, and a low LAA with a large AI have been associated with degenerative RCT (6, 8, 10). More recently, CSA has been introduced, which is a combination of the LAA and AI, and notably, a mighty association between large angles and degenerative RCT has been proven (7, 8, 11). Additionally, a recent study reported that higher CSA and AI increase re-tear risk after surgery (12).

Studies have reported that the morphology of the scapula is different among races and individuals from various countries and that this can affect the relationship between the morphology of the scapula and RCT (13, 14). Specifically, a recent study reported that North Americans have significantly lower CSA and AI than East Asians (13), in addition another study reported that the while AI cannot be used in the Japanese population, it can be used as a predictor of RCT in the Brazilian population (14).

Although aforementioned studies have identified acromion morphology and its adjacent structures as potential extrinsic factors of rotator cuff disorders, to the best of our knowledge, no study has evaluated this relationship in a Turkish population. Therefore, this study aims to evaluate the predictive power of CSA, AI, and LAA in degenerative RCT in a Turkish cohort, as these radiologic parameters have been used to discriminate between patients with and without RCT.

MATERIAL AND METHOD

Electronic medical records and surgical reports of 124 patients who underwent shoulder arthroscopy from 2015 to 2019 in our hospital were reviewed retrospectively for potential inclusion in the RCT group. Inclusion criteria for the RCT group were age greater than 40 years, availability of preoperative standard true anteroposterior radiographs, isolated non-traumatic full-thickness RCT. Magnetic resonance imaging (MRI) was used to confirm the diagnosis, and also intraoperative arthroscopic findings demonstrated the tear. We identified 47 patients with documented full-thickness supraspinatus tendon tears and categorized them as part of the RCT group. Next, the electronic medical records of 85 patients with shoulder pain admitted to our outpatient clinic from October 2019 to March 2020 were reviewed retrospectively, of which 45 subjects with an intact rotator cuff were included in the control group. Inclusion criteria for the control group were age greater than 40 years, availability of standard true anteroposterior radiographs, and presence of an intact rotator cuff confirmed by MRI. Exclusion criteria were as follows: history of surgery and trauma on the shoulder, age <40 years old, and missing preoperative true anteroposterior radiographs and shoulder MRIs. Of the 209 records in the database, 117 were excluded due to these criteria. Thus, data from 92 patients (RCT group, 47; control group, 45) were included in the analysis. Ethics committee approval was obtained, before initial of the study. The study was conducted in accordance with the Helsinki declaration principles.

Assessment of Radiologic Parameters

Two orthopedic surgeons independently analyzed all 92 radiographs and were blinded to each other's measurements, including those for CSA, AI, and LAA. Both observers were also unaware of the patients' MRI findings. All measurements were obtained electronically on true anteroposterior shoulder radiographs using the Infinity PACS system (Infinity Healthcare Co., Seoul, South Korea).

All measurements were performed as previously described (5, 7, 10). CSA was defined as the angle between the line connecting the top and bottom side points of the glenoid and the line connecting the outermost edge of the acromion and the inferior bone border of the glenoid (Fig. 1A). AI was calculated as the ratio of the line most suitable for the glenoid direction and the lateral-most point on the acromion and a line most suitable for the glenoid direction with the most lateral point on the humeral head (Fig. 1B). LAA was measured as the angle between the line connecting the superior-most and the inferior-most lateral points of the glenoid and the line connecting parallel to the acromion undersurface (Fig. 1C). The reproducibility of the measurements by the two independent observers was assessed using the intra-class correlation coefficient (ICC).

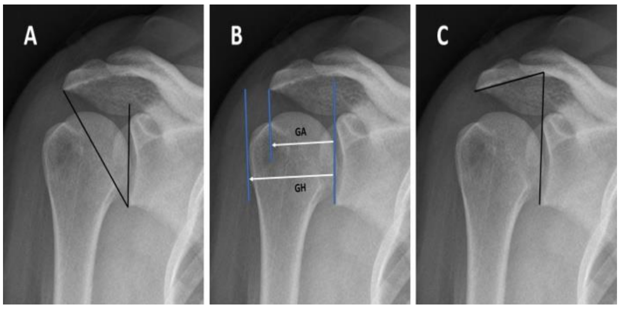

Figure 1. Schematic representation of the measurements. (A) CSA was determined between the glenoid plane and the lateral-most border of the acromion (B) AI was determined as the ratio of the distance between the glenoid plane and the lateral-most border of the acromion (GA) and distance between the glenoid plane and the lateral-most border of the humeral head (GH) (C) LAA was determined as the angle between the glenoid plane and the undersurface of the acromion.

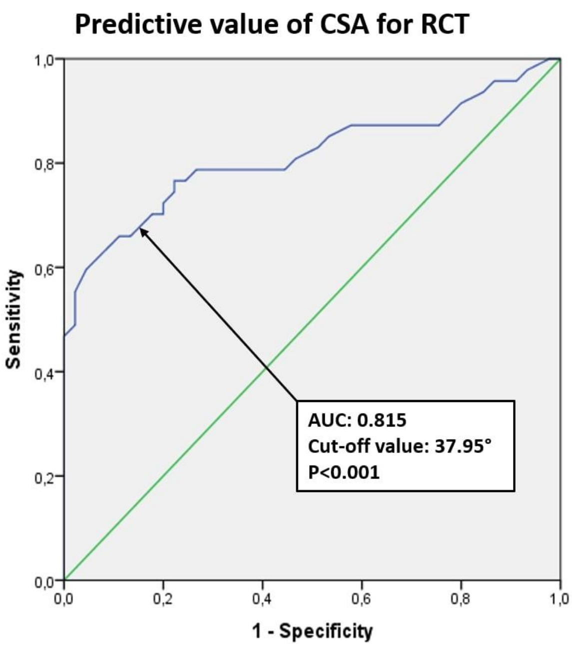

Figure 2. The predictive value of CSA for RCT using ROC curve analysis.

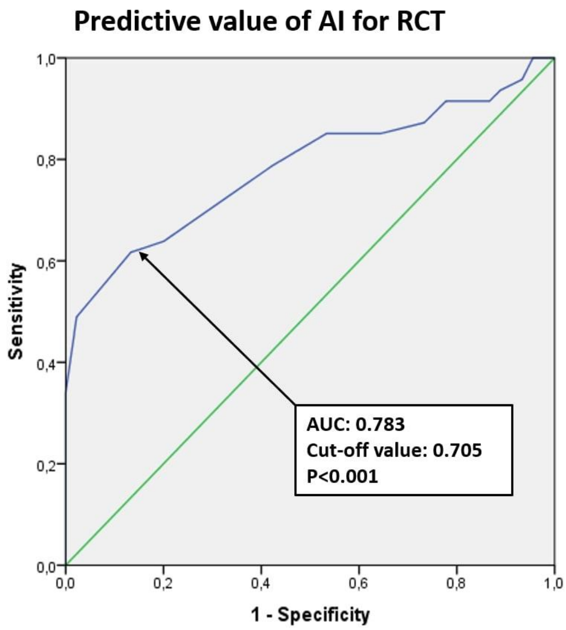

Figure 3. The predictive value of AI for RCT using ROC curve analysis.

Statistical Analyses

SPSS software version 20.0 (IBM Corp., Armonk, NY, USA) were used to perform statistical analyses. Descriptive statistics are presented as means, medians, standard deviation, ranges, and percentages. Inter-observer reliability was determined using ICC. Excellent reliability was defined as an ICC value of 0.8 or higher. Data was tested for normality using the Shapiro–Wilk test and was observed to be not normally distributed. Also, to analyze continuous variables Mann–Whitney U test was used. Each parameter was compared between groups using the Mann–Whitney U test. The Spearman rank correlation coefficient was used to analyze the relationships among AI, LAA, and CSA. Receiver operating characteristic (ROC) analysis and the Youden index method were used to determine the cutoff value for each parameter for predicting RCT. $p < 0.05$ was considered significant. The most important results are presented as tables and figures.

RESULTS

There were 47 and 45 patients in the RCT and control groups, respectively. The mean age of the RCT group was 58.91 ± 10.28 years (range, 42–78 years), while that of the control group was 55.311 ± 9.13 years (range, 41–72 years). The two groups were similar in terms of age (p = 0.079), gender proportion (p = 0.804), and injury side (p = 0.552). Interobserver reliability for CSA, LAA, and AI was determined to be excellent as the ICC values were 0.949 (95% confidence interval [CI], 0.923–0.966), 0.933 (95% CI, 0.899–0.956), and 0.868 (95% CI, 0.801–0.913), respectively. Table 1 presents the measurement values for all radiographic parameters. The mean values of CSA and AI in the RCT group showed significant higher values than those in the control group (CSA, p < 0.001; AI, p < 0.001), but no significant difference was observed between the groups in LAA (77.99° vs. 79.82°, respectively; p = 0.056).

Table 1. Summary table of all measured parameters

Parameters	RCT group (*n* = 47)	Control group (*n* = 45)	Total (*n* = 92)
CSA	38.1 ± 3.42 (range, 32.1–45.4)	34.56 ± 1.85 (range, 31.6–38.5)	36.37 ± 3.28 (range, 31.6–45.4)
LAA	77.99 ± 3.52 (range, 73.4–85.4)	79.82 ± 4.31 (range, 74.2–88.4)	78.89 ± 4.01 (range, 73.4–88.4)
AI	0.72 ± 0.06 (range, 0.61–0.84)	0.67 ± 0.03 (range, 0.60–0.72)	0.70 ± 0.52 (range, 0.60–0.84)

There was a moderate correlation between CSA and AI (r = 0.639, p < 0.001), whereas there was a low negative correlation between CSA and LAA (r = −0.220, p = 0.035) and no significant correlation between AI and LAA (r = −0.199, p = 0.057).

Since LAA did not show a significant difference between groups, we analyzed only CSA and AI with ROC analysis. Based on the ROC analysis, the optimal cutoff value of CSA for discriminating between RCT and control groups was 37.95°. As shown in Fig. 2, the area under the curve (AUC) for CSA was 0.815 at a cutoff value of 37.95°, corresponding to a sensitivity of 63.8% and a specificity of 54.9% (95% CI, 0.723–0.906; p < 0.001). The optimal cutoff value for AI for discriminating between RCT and control groups was 0.705. As shown in Fig. 3, the AUC of AI was 0.783 with a cutoff value of 0.705, corresponding to a sensitivity of 61.7% and a specificity of 48.4% (95% CI, 0.687–0.879; p < 0.001). CSA was ≥37.95° in only 4 of 45 (8.9%) patients in the control group, whereas it was ≥37.95° in 30 of the 47 (63.8%) patients in the RCT group. Moreover, AI was ≥0.705 in only 7 of the 45 (15.6%) patients in the control group, whereas 29 of the 47 (61.7%) patients in the RCT group had AI values that were greater than 0.705. Furthermore, when CSA and AI were evaluated together to detect degenerative RCT, either or both of them were above the expected cutoff value of 79.1% of the patients in the RCT group.

DISCUSSION

Our results demonstrate an association between increased CSA and AI values and the presence of degenerative RCT, with CSA and AI values being significantly larger in the RCT group than in the control group. Further, we show that CSA and AI are potential predictors of degenerative RCT in a Turkish cohort. These results are in accordance with those of previous studies (7-9, 11, 15, 16).

Individual variations of scapular morphology, especially LAA were associated with the presence of degenerative RCT (5, 7, 17). Moor et al. introduced CSA as a parameter that combines both potential risk factors to a single radiological parameter, that is, integrates into the lateral expansion of the acromion and the glenoid slope (7). Also higher values of CSA were reported as a risk factor for degenerative RCT by these authors. Gerber et al. reported that a high CSA can cause the supraspinatus tendon to overload, especially in low degrees of active abduction after testing this hypothesis in a study (17). A systematic review investigated the potential influence of CSA as a risk factor for the advancement of degenerative RCT (18), and data analyzed from 998 patients showed that mean CSA values ranged from 33.9° to 41.01° in the degenerative RCT group, while those in the control group (n = 538) ranged from 30.2° to 37.28°. (18) In our study, the mean overall CSA was 36.37°, and the CSA was higher in the RCT group, corresponding with the previous studies (7, 8, 11, 15-21). To determine the presence of degenerative RCT Moor et al. assessed the predictive power of AI, LAA and CSA and concluded that among the three, CSA was the strongest predictive parameter that could distinguish between patients with or without tendon discontinuity (8). Our findings confirm the results of the Moor et al. in showing that CSA is the strongest radiographic predictor of the presence of degenerative RCT.

Nyffeler et al. first described that the lateral extension of the acromion can cause RCT, which was termed AI (5), and found that the mean AI was 0.73 in patients with full-thickness RCT, while it was 0.64 in the control group. Thus, they correlated full-thickness RCT with larger extension of the acromion laterally (5). Torrens et al. in Spain also reported that patients with RCT had a significantly higher AI value of 0.72 compared to 0.68 in patients without cuff pathology (22). Many studies in the following years have also reported a relationship between AI and degenerative RCT, concurring with results of Nyffeler's study (6, 9, 14, 20, 22, 23). Interestingly, a correlation was reported between an increase of retear and higher CSA and AI after arthroscopic repair of supraspinatus tendon (12). The mean AI in our RCT group (0.72) was higher than that of the control group (0.67) and is similar to that reported previously. Additionally, AI was found to be a powerful radiographic predictor of the presence of degenerative RCT. Additionally, when CSA and AI were evaluated together to detect degenerative RCT, either or both the parameters were above the determined cutoff values in 79.1% of the patients in the RCT group.

With respect to LAA, Banas et al. have evaluated the slope of the acromion on MRI and showed that patients with rotator cuff disease had a lower LAA (10). In their study, mean LAA was 78° (range, 64°–99°), and while angles were lower in patients with tendon discontinuity, higher angles were found in patients with intact tendon. Further, all patients with LAA angle below 70 ° had full-thickness RCT. Despite LAA being initially only described on MRI, some studies also demonstrated its applicability on conventional radiographs with good inter-observer reliability (6, 8). Balke et al. (6) evaluated LAA in conventional radiographs and found that a low LAA was associated with higher prevalence of RCT. They also reported that a LAA of less than 70° only occurred in patients with degenerative RCT (6). In contrast, another clinical study found that LAA was not related to RCT (15) as the mean LAA was 81.2° in the RCT group and 82.6° in the non-RCT group (15). Here, even though mean LAA in the RCT group was lower than the control group, the difference was not statistically significant. Additionally, while we found a moderate correlation between CSA and AI, there was only a low correlation between CSA and LAA and no significant correlation between AI and LAA. Finally, while CSA and AI were related to degenerative RCT, LAA was not. One explanation for this may be that, while CSA and AI reflect lateral extension of the acromion, LAA is independent of the lateral extension of the acromion; rather, LAA measures the inclination of the glenoid. Therefore, extension of the acromion to the lateral may be a stronger indicator for the risk of RCT rather than the glenoid slope. It must be noted here that individual or racial differences may have affected our results.

Many previous studies from different countries have investigated the relationship between the presence of degenerative RCT and scapular morphology with varied results. For instance, Miyazaki et al. have suggested that while AI cannot be used in the Japanese population, it can be used as a predictor of RCT in the Brazilian (14). In addition, a recent study reported that North Americans have significantly lower CSA and AI than East Asians (13). Therefore, these parameters, which measure scapular anatomy, may vary between individuals and races. Although many international reports exist, the association between the abovementioned parameters and RCT has not been investigated in the Turkish population, this study aims to analyze the relationship between degenerative RCT and parameters of the acromion morphology, comprehensively in a Turkish cohort.

This study has several limitations. First, this was a retrospective, single-center study in a Turkish cohort, so the results may not be generalizable to other populations. Second, the relatively small number of subjects has limited the power of the study. Third, we did not account for a possible relationship between the presence of RCT and the shape of the acromion and acromiohumeral interval. Finally, this study did not take into account the role of intrinsic factors such as diabetes, genetics, and smoking in the development of RCT. Large prospective studies are needed to confirm our preliminary results.

In conclusion, we show that CSA and AI, measured by means of simple radiographic analysis and with high inter-observer reliability, are useful parameters for detecting degenerative RCT. Consequently, CSA and AI can be used as potential predictive factors for degenerative RCT in the Turkish population. Further studies with a larger study population are essential to confirm our preliminary results.

Conflict of Interest

The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

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