ORIGINAL ARTICLE

Nr 2022;12 (3):286-289

The Critical Shoulder Angle in a Middle Eastern Cohort: is There an Association with Rotator Cuff Tear?

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DOI:
10.32098/mltj.03.2022.04

LEVEL OF EVIDENCE: 3

SUMMARY

Background. The critical shoulder angle (CSA) has been used as a tool for identifying patients with high risk of developing a rotator cuff tear (RCT). A CSA angle larger than 35 degrees has been shown to be associated with increased risk of RCT. The aim of this study was to determine if this concept is applicable to a Middle Eastern cohort of patients.

Methods. This retrospective observational study included 44 patients who underwent rotator cuff repair between 2016 and 2021 in KFUH was compared to 45 patients with normal shoulders. The CSA was measured by two independent observers on anterior-posterior radiographs. The collected data was analyzed. P-values of < 0.05 were considered statistically significant.

Results. The mean ± standard deviation (SD) CSA measured on pre-operative radiographs was significantly higher in patients with RCT (36.66° ± 4.62°) compared to patients with normal shoulder (31.97° ± 3.37°), P-value < 0.033.

Conclusions. Our current study confirms that the association of high CSA with risk of rotator cuff tears is applicable in a cohort of Middle Eastern patients, as the CSA was higher in patients who underwent RCT repair when compared to patients with normal shoulders.

KEY WORDS

Critical shoulder angle; Rotator Cuff Tear; shoulder; radiographs; MRI.

INTRODUCTION

Rotator cuff tears (RCT) are common shoulder injuries seen by orthopedic surgeons in their practice. These injuries can lead to significant disability and loss of function if not managed properly (1, 2). Recent attention has been directed towards identifying factors that may predispose patient to these types of injuries. These include increasing age, smoking status and commonly a history of shoulder trauma (3, 4). Interest has also increased in identifying radiographic risk factors for RCTs, one of which is the critical shoulder angle (CSA). This angle is formed by a line extending between the superior and inferior borders of the glenoid and a line connecting the glenoid to the inferolateral aspect of the acromion on a standard anterior-posterior radiograph (AP) of the shoulder (5-9). A CSA angle larger than 35 degrees has been shown to be associated with increased risk of

RCTs, while an angle less than 30 degrees was found to be a risk factor for osteoarthritis (5, 10).
Kim *et al*. assessed the association of degree of CSA with risk of sustaining RCTs by subdividing patients into high (> 38°), middle (33-38°) and low (< 33°) CSA groups. They found in their study that the high group had a significantly higher risk of RCTs (84.6%), while this was lower in the middle and low group (60.3% and 68.3%, respectively) (11).
The aim of our current study is to assess the association of CSA with RCTs in a Middle Eastern patient cohort. As this is a newly introduced radiographic concept, we believe that the results of this previously unreported patient cohort will add to the current literature.

METHODS

We performed a retrospective observational study to evaluate patients who underwent RCT repair at King Fahd Hospital of the University, Al-Khobar, Saudi Arabia between February 2016 to November 2019. Institutional review board approval was obtained prior to the onset of the study (Imam Abdulrahman Bin Faisal University. IRB: UGS - 2019-01-320).
Inclusion criteria were all middle eastern patients who underwent RCT repair at our institute and had adequate shoulder AP radiographs. Exclusion criteria included non-middle eastern patients, patients with history of previous shoulder surgery and patients with incomplete records or radiographs. A cohort of patients presenting to clinic with normal shoulders, confirmed by both clinical exam and magnetic resonance imaging (MRI) were included as a comparison group. Demographic data, medical history and operative records were collected retrospectively from the patient's files.
The CSA was then measured on patient's pre-operative AP shoulder radiograph in the RCT group and in the normal shoulder group by two observers (**figures 1, 2**). This was performed by them twice, with a two-week interval. Inter-observer and intra-observer reliability was analyzed and reported. In addition, the size of the tear and tendon retraction were measured by a fellowship trained musculoskeletal radiologist on the RCT group patients' pre-operative MRI (**figures 1, 2**).
A power analysis was performed using the data from Cherchi *et al*. (5). We calculated that a sample size of 64 was required to obtain a power of 80% and $\alpha = 0.05$.
Data was collected and descriptive statistics were analyzed using SPSS, version 26 (Armonk, NY: IBM Corp, USA). For data analysis the Independent-Samples t test was performed to compare the variables. Interclass Correlation Coefficients (ICC) was used to measure the interobserver and intra-observer reliability. P-value < 0.05 was considered to be significant.

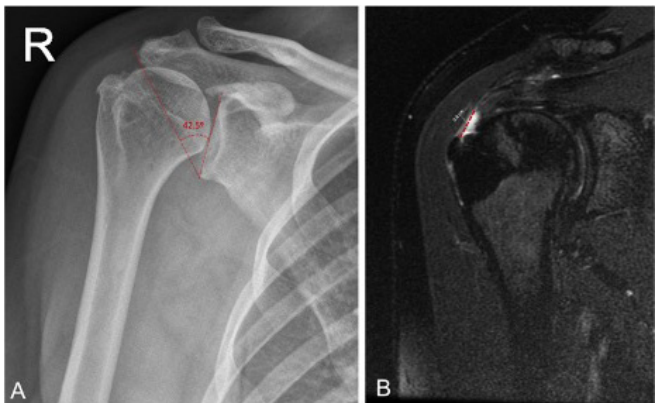

Figure 1. (A) Anterior-posterior radiograph of the right shoulder demonstrating a Critical Shoulder Angle (CSA) of 42.5 degrees. **(B)** Coronal PD fat saturated MRI image of the same patient demonstrating a large full thickness tear of the supraspinatus tendon. The tendon tear measured about 2.5 cm in anterior to posterior dimension and retraction of the torn tendon stump by about 0.8 cm.

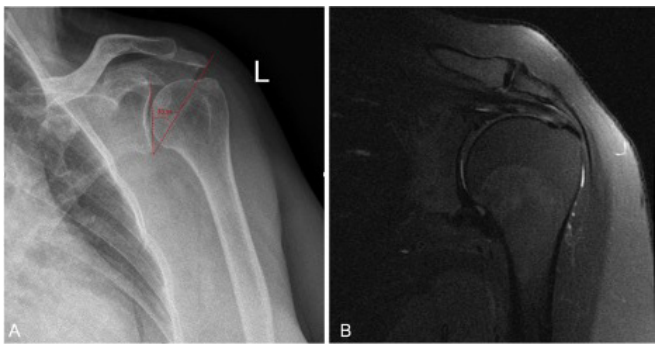

Figure 2. (A) Anterior-posterior radiograph of the left shoulder demonstrating a Critical Shoulder Angle (CSA) of 33.5 degrees. **(B)** Coronal PD fat saturated MRI image of the same patient demonstrating normal appearance of the rotator cuff tendons without a tear.

RESULTS

A total of 89 patients were included in the study, 44 patients in the RCT group and 45 patients in the normal shoulder group. The mean age of patients in the RCT group was 54.8 years ± 8.2, while in the normal shoulder group was 53.7 years ± 7.7, with no significant difference between the two groups (**table I**). The majority of patients were males in the RCT group (54.5%) and females in the normal shoulder group (66.7%), but this was not statistically significant (**table I**). All patients in the RCT group had an arthroscopic repair of RCT, with 17 of them requiring a subacromial decompression and one patient requiring an acromioplasty during the initial operation.

Table I. Demographic data of patients included in the study.

Demographics		RCT group	Normal Shoulder Group	P-value
Age (years), mean ± SD		54.8 ± 8.2	53.7 ± 7.7	0.776
CSA (mean ± SD)		36.7° ± 4.6°	31.9° ± 3.4°	0.033
Gender, n (%)	Female	20 (45.5%)	30 (66.7%)	0.044
	Male	24 (54.5%)	15 (33.3%)	

RCT: rotator cuff tear; CSA: critical shoulder angle; SD: standard deviation; n: number of shoulders.

The CSA measurement showed excellent reliability. The interobserver reliability of CSA measurement was 0.815 and the intra-observer reliability was 0.903.

The mean CSA measured on pre-operative radiographs was 36.66° ± 4.62° in the RCT group *versus* 31.97° ± 3.37° in the normal shoulder group. This difference was statistically significant (P-value < 0.05). Of the RCT group 63.6% had a CSA of 35° or more, while in the normal shoulder group it was only 13.3%.

We further subclassified the CSA into high (> 40°), middle (38-40°) and low (< 38) risk groups. Of the total 44 patients, 12 patients were in the high-risk group (27.3%), 6 patients (13.6%) were in the middle-risk group and 25 patients (56.8%) were in the low-risk group in the RCT group. While in the normal shoulder group only 1 patient was high risk (2.2%), 2 as middle risk (4.4%) and 42 with a low-risk CSA (93.3%).

DISCUSSION

Our current study evaluated the association between high CSA and risk of sustaining a RCT in a middle eastern population cohort. The mean CSA of patients with RCT included in our cohort was 31.97° ± 3.37°, this is similar to previously reported literature in other populations (3, 5, 7, 10-13). We also found that the majority of patients with RCT had a CSA higher than 35 (63.6%). This also aligns with preceding studies showing a significant association between higher CSA measurement and risk of RCT (3, 5, 11, 12). In addition, we have also confirmed the association of high CSA with RCT, as the CSA was significantly higher in patients with RCT compared to patients with normal shoulders. In our current study, we found no statistical differences in age and gender between normal and RCT groups. Gumina *et al.* studied the association of age and gender with CSA and risk of RCT in the general population and found that increasing age was associated with higher CSA and thus risk of RCT (14).

When CSA was classified into high-risk, middle-risk and low-risk groups, a large proportion of patients with RCT were among with high risk (CSA > 40) group (27.3%). This is consistent with Kim *et al.* findings that patients in the higher CSA group had a higher incidence of RCT compared to patients in the middle CSA group (11, 15, 16).

Several studies have confirmed good reliability of CSA measurement on AP radiograph (3, 5, 11). Kim *et al.* reported an inter-observer reliability of 0.897 and intra-observer reliability of 0.993 (11). We also demonstrated an excellent inter-observer and intra-observer reliability, which were 0.948 and 0.993, respectively.

A possible limitation of the study is that the shoulder radiographs obtained for CSA measurement can be affected by several factors such as projection and patient position. At our institution we perform these radiographs under a standardized protocol, thus minimizing the variations in studied images. Also, the CSA angle measurement has been shown to have excellent reliability in previous studies (5, 11). Another possible limitation is the small sample size, but we performed a power analysis using previously published literature prior to the study (32 patient per group).

CONCLUSIONS

We have shown that in a Middle Eastern population cohort, high CSA was associated with developing RCTs, thus confirming that this angle can be applied as a predictor of patients' risk of sustaining a RCT. Additional studies are encouraged to assess this association in different populations and patient cohorts.

FUNDINGS

None.

DATA AVAILABILITY

Data are available under reasonable request to the corresponding author.

CONTRIBUTIONS

SMA, AAA. TMH: conceptualization, design, study execution, manuscript writing and review. FA, ZA, NA, WA, FA,

SA, AAA, MMA: study execution, manuscript writing and review. SSA: statistical analysis, manuscript writing and review.

CONFLICT OF INTERESTS

The authors declare that they have no conflict of interests.

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