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ORIGINAL ARTICLE

The critical shoulder angle is associated with osteoarthritis in the shoulder but not rotator cuff tears: a retrospective case-control study

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Background: In 2013 Moor et al introduced the concept of the critical shoulder angle (CSA) and suggested that an abnormal CSA was a leading factor in development of rotator cuff tear (RCT) and osteoarthritis (OA) of the shoulder. This study assessed whether the CSA was associated with RCT and OA and tested the inter- and intrarater reliability of the CSA when measuring RCT and OA.
Materials and methods: The study was performed as a retrospective case-control study. The cases comprised 2 groups: 97 patients with RCT and 87 patients with OA. The controls were matched 3:1, by age and sex, from a population of 795 patients with humeral fractures. The CSA was measured as described by Moor et al. Analysis of the relation with CSA for RCT and OA was done by logistic regression. Models were fitted separately for RCT and OA and used the controls matched to the respective cases. Inter- and intrarater reliability was determined by measuring the intraclass correlation coefficient and minimal detectable change.
Results: The mean CSA was 33.9° in the RCT group and 33.6° in the matched control group. The odds ratio for developing RCT for people with a CSA above 35° was 1.12 ($P = .63$). The mean CSA in the OA group was 31.1° and in the matched control group 33.3°. The odds ratio for developing OA for people with a CSA below 30° was 2.25 ($P = .002$). The CSA measurements showed strong intra- and inter-rater reliability, with intraclass correlation coefficient values above 0.92 and minimal detectable change values below 0.4°.
Conclusions: This study did not find any association between CSA and RCT but did show association between CSA and OA, with a 2.25 odds ratio of developing OA given the patient had a CSA below 30°. The results do not support the suggested praxis of shaving away the lateral border of the acromion to make the CSA smaller because it might increase the risk of developing OA without decreasing the risk of developing RCT. The CSA measurements showed excellent intra- and inter-rater reliability.
Level of evidence: Level III; Retrospective Case Control Design; Prognosis Study

Keywords: Critical shoulder angle; rotator cuff tear; shoulder osteoarthritis; shoulder radiograph; humeral fractures; shoulder

The trial was retrospective and followed the rules specified by the Helsinki-II Declaration.

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In 2013, Moor et al[6] introduced the concept of the critical shoulder angle (CSA) and suggested that an abnormal CSA was a leading factor in development of osteoarthritis (OA) and rotator cuff tear (RCT). Since then, a series of studies have investigated the association between CSA and RCT or OA, supporting the primary findings of Moor et al.[1,2,4,8,9]

The CSA is defined as the angle formed by a line connecting the superior and inferior bony margins of the glenoid and a line drawn from the inferior bony margin of the glenoid to the most lateral border of the acromion measured on an anterior-posterior (AP) shoulder x-ray image. Moor et al[6] measured the CSA on 94 asymptomatic shoulders, 102 shoulders with magnetic resonance imaging–documented full-thickness RCTs without OA, and 102 shoulders with primary OA and no RCT. A CSA of 33.3° (standard deviation, 2.2°) was found in healthy shoulders. CSA values were classified and graded from 1 to 3: grade 1 was defined as CSA <30°; OA was present in 93% in this group. Grade 2 was defined as CSA between 30° and 35°; 70% were in the control group, 16% in the OA group, and 14% in the RCT group. Grade 3 was defined as CSA >35°; an RCT was present in 84% in this group.[6] Moor et al[6] used these results to suggest that a CSA <30° disposed to OA because a short acromion would lead to an increased scapula-humeral pressure caused by the pulling direction of the deltoid. Likewise, a CSA >35° was suggested to dispose to RCT because a long acromion would give the deltoid muscle an antagonizing pulling direction compared with the supraspinatus muscle.

The CSA has a high intraobserver reliability (intraclass correlation coefficient [ICC], 0.909; 95% confidence interval [CI], 0.818-0.956) and interobserver reliability (ICC, 0.869; 95% CI, 0.776- 0.930) when measured on radiographs. The reliability parameters were better on radiographs than on magnetic resonance imaging.[8]

The present study tested the primary finding of Moor et al[6] by assessing whether the CSA was associated with RCT and OA in a case-control study allowing for causal claims to be made and tested intra- and inter-rater reliability of CSA. The study hypothesis was that a CSA of >35° would be associated with RCT and that a CSA of <30° would be associated with OA.

Materials and methods

The study was performed as a retrospective case-control and reliability study following the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for reporting case-control studies.

Participants

The patient cohort consisted of patients admitted to Zealand University Hospital from January 1, 2009, to December 21, 2014, with one of the following conditions: RCT (International Classification of Diseases, Tenth Revision, code DS46.0), OA of the glenohumeral joint (DM190-199), or proximal humeral fracture (DS422). Patients with proximal humeral fractures were the control group because they are believed to be overlapping in age and sex, making it possible to match the populations on these factors and because the fracture pattern does not interfere with the CSA measurement.

Data extraction

Data were extracted from the national patient register by use of the above-mentioned International Classification of Diseases, Tenth Revision codes. All health care providers in Denmark are obliged to register all inpatient and outpatient contacts, using the unique patient identifier, the Civil Personal Registration number. Correct registration in the national patient register is paramount to receiving payment for admissions and procedures, and as such, the completeness of the register is expected to be 100%.

CSA measurement

The unique patient identifier was used to retrieve patient radiographs from the x-ray image server. The Easyviz 6.1.2.171 x-ray image viewer (Medical Insight, Karos Health, Waterloo, ON, Canada), was used to analyze the images, and the built-in angle measurement feature was used to measure the CSA, according Moor et al,[6] as the angle between a line connecting the inferior and superior rim of the glenoid fossa and another connecting the inferior rim of the glenoid with the most inferolateral point of the acromion.[1] Measurements were performed on true AP radiographs with the x-ray beam perpendicular to the plane of the scapulae. Thereby, a true view of the glenohumeral joint was seen with visible joint space and minimal overlap between the anterior and posterior rim of the glenoid cavity.[2]

Exclusion of malrotated pictures

A true AP image was defined by Moor et al[6] as a picture with maximum 20° malrotation of the scapulae.[1] In the present study, assessing rotation of the scapula in degrees was not possible because this cannot be done on an AP image of the shoulder. Instead, malrotation was assessed by measuring the overlap of the anterior and posterior rim of the glenoid fossa. To determine the overlap equaling 20° of malrotation, x-ray images in 9 patients were taken in 20° malrotation. The patients were positioned with the scapula parallel to the x-ray receiver, and the camera was rotated 20° laterally. This led to an average overlap of 14.8 mm (mean, range, 5-25 mm). After removal of the most extreme values (highest and lowest), the range was 11 to 20 mm. An overlap of 11 mm was determined to equal 20° of malrotation, and x-ray images with an overlap of the anterior and posterior rim of 11 mm or more were excluded.

Sample size

The sample size calculation was made with a minimal clinically relevant odds ratio (OR) between RCT and control of 3, power of 0.80, and significance level of 0.05 with 3 controls per case, this showed a need for 71 cases and 213 controls. Likewise for OA with equal OR, power and significance level, and number of controls per case, 71 cases and 213 controls were needed.