Orthopaedics & Traumatology: Surgery & Research 102 (2016) 559–562

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Original article

Critical shoulder angle: Measurement reproducibility and correlation with rotator cuff tendon tears

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ARTICLE INFO

Article history:
Received 24 August 2015
Accepted 21 March 2016

Keywords:
Anatomy
Shoulder
Scapula
Rotator cuff
Radiographs
Acromion

ABSTRACT

Background: Associations have been reported linking rotator cuff tears (RCTs) to both greater lateral extension of the acromion and greater inclination of the glenoid cavity. These two factors combined can be assessed using a recently introduced parameter, the critical shoulder angle (CSA). The primary objective of this study was to confirm the association linking a high CSA value to RCTs, and the secondary objective was to assess the reproducibility of CSA measurement using a goniometer.
Hypothesis: The null hypothesis was that the CSA value in a group of patients with RCTs was not significantly different from that in patients with anterior shoulder instability and a Bankart lesion, taken as the general population for this study.
Methods: After a power estimation, we retrospectively included 28 patients with a mean age of 55.5 years who had surgery for RCTs and 27 patients with a mean age of 27.2 years who underwent anterior labral repair. Two surgeons used a goniometer to measure the CSA in each patient. Reproducibility was assessed based on Bland-Altman plots and Pearson's correlation coefficient.
Results: The mean CSA was significantly higher ($P=0.02$) in the RCT group ($36.4^\circ \pm 4.4^\circ$; range: 30°–46°) than in the labral-repair group ($33.3^\circ \pm 3.8^\circ$; range: 25°–41°). Intra-observer reproducibility was 96.7% and inter-observer reproducibility was 95.5%.
Conclusion: Our results support previously published evidence that the CSA is significantly greater in patients with RCTs. Thus, an anatomical difference seems to exist between patients with RCTs and the general population. The CSA measured on a standard radiograph using a goniometer provides a reproducible assessment of this anatomical difference.
Level of evidence: IV, case-control epidemiological study with a power estimation.

1. Introduction

Rotator cuff tears (RCTs) are multifactorial lesions whose prevalence increases with age [1,2]. Until recently, the influence of acromial geometry was chiefly assessed in terms of the subacromial impingement syndrome described by Neer [3] and Armstrong [4]. New studies indicate, however, that several anatomical features of the scapula such as marked lateral extension of the acromion and upward inclination of the glenoid are associated with RCTs [3,5–11]. The critical shoulder angle (CSA) is a tool developed by Moor et al. [9,10] to assess these two anatomical factors using a single parameter. CSA values greater than 35° were found to be associated with RCTs and lower than 30° with gleno-humeral osteoarthritis.

The primary objective of this study was to confirm the association linking a high CSA value to RCTs. The secondary objective was to evaluate the reproducibility of CSA measurement using a goniometer. The null hypothesis was that the CSA in a group of patients with RCTs was not significantly different from that in a group of patients with anterior labral tears, taken as the general population for this study.

2. Population and methods

2.1. Inclusion criteria

The sample size required to obtain greater than 95% statistical power with the alpha risk set at 5% was estimated. Then, 89 cases were considered from the lists of consecutive

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http://dx.doi.org/10.1016/j.otsr.2016.03.017
1877-0568/

Fig. 1. Measurement of the critical shoulder angle (CSA). CSA measurement on an anterior-posterior double-obliquity radiograph of the shoulder. The CSA is subtended by a line parallel to the glenoid and a line through the inferior-lateral edge of the glenoid and the inferior-lateral edge of the acromion.

patients who had had RCT repair or anterior labral repair since 2011. Among them, 9 RCT patients and 15 labral-repair patients were excluded because of missing preoperative imaging studies (anterior-posterior double-obliquity radiograph, computed arthrotomography, magnetic resonance imaging, or magnetic resonance arthrography). Furthermore, a history of surgery on the same shoulder led to the exclusion of 7 RCT patients and 3 labral-repair patients.

This left 55 patients for the study, 28 in the RCT group (mean age: 55.5 years) and 27 in the labral-repair group (mean age: 27.2 years). The indication for arthroscopic labral repair was post-traumatic anterior shoulder instability.

2.2. Assessments

The CSA was measured on an anterior-posterior double-obliquity radiograph of the shoulder as the angle subtended by a line parallel to the glenoid and a line through the inferior-lateral edge of the glenoid and the inferior-lateral edge of the acromion [9] (Fig. 1).

Two observers, designated A and B hereafter, measured the CSA in each patient, using a goniometer. Inter-observer reproducibility was assessed by comparing the values obtained by these two observers and intra-observer reproducibility by having observer A repeat the measurements after a 3-week interval.

Furthermore, observer A used the scapular Y radiograph to assess the acromion in each patient according to the classification described by Bigliani et al. [12].

2.3. Statistical methods

Fisher's exact test was chosen to compare categorical variables and the Wilcoxon–Mann–Whitney rank-sum test to compare continuous variables. Reproducibility of the measurements was evaluated using both Bland–Altman plots and Pearson's correlation coefficient.

Univariate analyses were performed to compare the characteristics of the two groups. Then, exploratory multivariate analyses were done to look for explanatory variables. Receiver-operating characteristic (ROC) curves were plotted to determine the CSA cut-off that provided the best sensitivity and specificity.

3. Results

Intra-observer reproducibility was 96.7% and inter-observer reproducibility was 95.5%. Differences in measured values are shown on the Bland–Altman graphs in Fig. 2.

The RCT and labral-repair groups differed significantly for mean age (55.5 ± 7.07 years, range: 42–73, versus 27.2 ± 9.33 years, range: 14–50, $P < 0.001$); the proportion of patients in manual or heavy labour occupations (75% versus 25%, $P < 0.001$); and the proportion of Bigliani type II and III acromions, which was higher in the RCT group ($P < 0.01$).

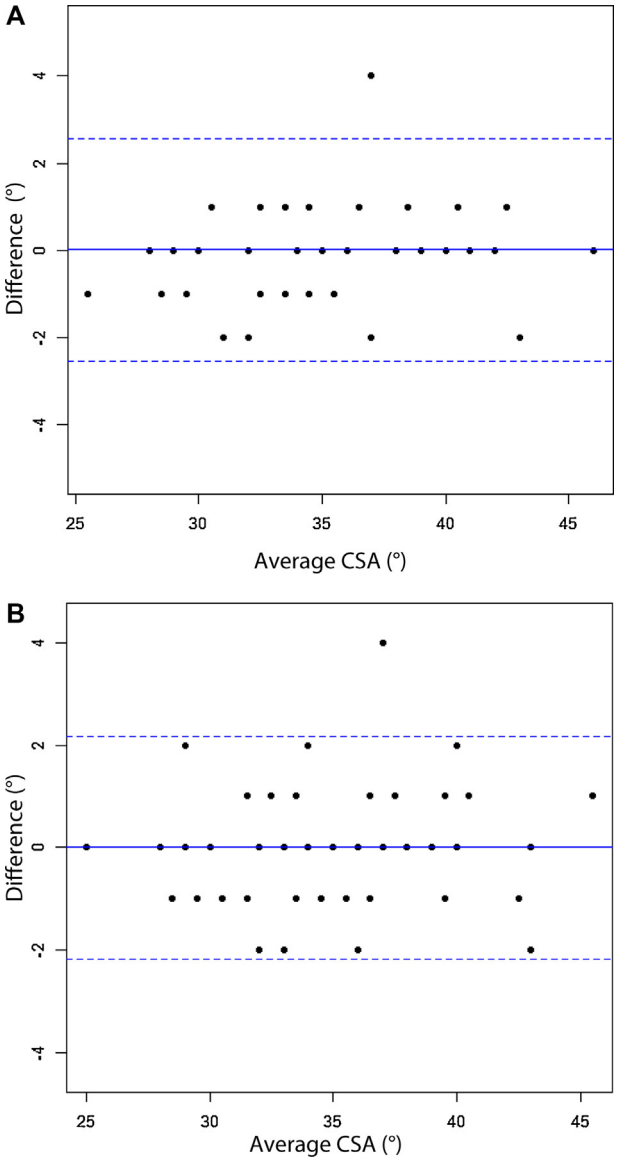

Fig. 2. Inter-observer (A) and intra-observer (B) measurement differences assessed using Bland–Altman plots.