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Original article

Age, trauma and the critical shoulder angle accurately predict supraspinatus tendon tears

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ABSTRACT

Background: The pathogenesis of full-thickness tears of the rotator cuff remains unclear. Apart from age and trauma, distinct scapular morphologies have been found to be associated with rotator cuff disease. The purpose of the present study was to evaluate whether a score formed using these established risk factors was able to predict the presence of a rotator cuff tear reliably.
Methods: We retrospectively assessed a consecutive series of patients with a minimal age of 40 years old, who had true antero-posterior (AP) radiographs of their shoulders, as well as a magnetic resonance (MR) gadolinium-arthrography, between January and December 2011. In all of these patients, the critical shoulder angle (CSA) was determined, and MR images were assessed for the presence of rotator cuff tears. Additionally, the patients' charts were reviewed to obtain details of symptom onset. Based on these factors, the so-called rotator cuff tear (RCT) score was calculated.
Results: Patients with full-thickness RCTs were significantly older and had significantly larger CSAs than patients with intact rotator cuffs. Multiple logistic regression, using trauma, age and CSA as independent variables, revealed areas under the curve (AUCs) for trauma of 0.55, for age of 0.65 and for CSA of 0.86. The combination of all three factors was the most powerful predictor, with an AUC of 0.92.
Conclusion: Age, trauma and the CSA can accurately predict the presence of a posterosuperior RCT.
Level of evidence: Level IV. Case series with no comparison groups.

1. Introduction

Rotator cuff tears (RCTs) are among the most frequent pathologies of the shoulder girdle [1]. Despite their considerable socioeconomic impact, there remains substantial controversy concerning their pathogenesis. Some tears are traumatic, but the vast majority are most likely degenerative and definitely age-related, as documented by prevalence data [2–5]. However, several risk factors, such as distinct scapular morphologies, seem to be able to accelerate the age-related degeneration [6–15].

Among the various radiographic parameters associated with degenerative RCTs, we recently identified the critical shoulder angle (CSA) as a powerful predictor of the occurrence of rotator cuff tears [10]. The purpose of the present study was to quantify the individual predictive power of age, trauma and the CSA for the presence of rotator cuff disease and to evaluate to what extent the combination of all three factors allowed for the anticipation of a patient's individual risk of experiencing a RCT.

2. Materials and methods

2.1. Patient selection

This study was conducted at the Balgrist University Hospital according to the medical-ethical guidelines of our institution, after obtaining informed consent from all of the individuals studied for retrospective data analysis. All patients older than 40 years old, who had a true antero-posterior (AP) radiograph of their shoulders, taken with the central X-ray beam parallel to the glenoid fossa, depicting a clear joint space and only minimal overhang between the anterior and posterior glenoid rim, plus magnetic resonance (MR) gadolinium-arthrography between January

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and December 2011, were included. A total of 599 patients with 607 shoulders met these inclusion criteria. The mean age of these 251 women and 348 men was 56.7 years (SD 10.4, range 40–88 years).

The patients' charts were retrospectively reviewed to obtain details of the symptoms leading to the imaging, and all of the shoulders were classified into one of three groups. In 398 shoulders (65.6%), complaints started spontaneously without any preceding trauma and were graded as "Trauma 0". In 159 shoulders (26.2%), classified as "Trauma 1", symptom onset was triggered by an accident (e.g., shoulder contusions or distortions), but no data quantifying the severity of the incidents were available. Finally, "Trauma 2" was attributed to 50 shoulders (8.2%) in which symptom onset was associated with a relevant documented accident (e.g., glenohumeral joint dislocation or fracture at the level of the shoulder girdle).

2.2. Radiological assessment

2.2.1. MR arthrography

Highly experienced, fellowship-trained musculoskeletal radiologists evaluated all of the MR arthrographic images. Imaging was performed with a 1.0-T unit (Siemens, Erlangen, Germany). The quality of the rotator cuff tendons was assessed on 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 [16,17].

According to the radiological report, the integrity of the SSP tendon was classified into five categories. SSP 0 consisted of a normal tendon with a homogeneous, low-intensity signal on each image. SSP I consisted of tendinopathy with an increased intrasubstance signal but without pooling of contrast medium into the tendon substance. Bursal-sided and articular-sided partial tendon tears were graded as SSP II and III, respectively. A full-thickness tendon tear was graded as SSP IV. Additionally, the presence of full-thickness tears of the infraspinatus and subscapularis tendons was documented.

2.2.2. Conventional radiography

Two independent readers assessed the CSA on standardized, true antero-posterior radiographs. Both readers were blinded to the patients' MRI findings. All of the measurements were electronically obtained on radiographs displayed on a PACS workstation (Cerner Corp., Kansas City, MO, USA). Two lines, as previously reported, determined the CSA: the first line connected the superior and inferior osseous margins of the glenoid [10]; the second line was drawn from the inferior osseous margin of the glenoid to the most lateral border of the acromion (Fig. 1).

2.3. Statistical analysis

Statistical analysis was performed with the SPSS statistical software (SPSS Inc., Chicago, IL, USA). Descriptive analysis was performed to report means and standard deviations (SDs), as well as the ranges of the data. Intergroup comparison was achieved by means of statistical testing using the two-tailed unpaired *t*-test. Inter-rater reliability was assessed using the Bland-Altman method [18]. A multiple logistic regression, with trauma, age and CSA as independent variables, was performed to construct a predictive score for SSP tearing. Age and CSA were entered as continuous variables and trauma as a binary variable. The Hosmer-Lemeshow test was used to check the model fit. The regression coefficients were then rounded, and the two models were compared using the area under the receiver-operating characteristic (ROC) curve. Statistical significance was defined as $P < 0.05$.

Fig. 1. Assessment of the critical shoulder angle (CSA) on standardized true antero-posterior radiographs. The angle is formed by a line connecting the superior and inferior border of the glenoid fossa and a second line connecting the later with the most infero-lateral point of the acromion.

3. Results

The CSA demonstrated excellent inter-rater reliability, with minimal bias between reader A and reader B of 0.12° (limits of agreement of –2.2° to +2.7°; see Fig. 2).

MR arthrographic imaging revealed 134 cases of SSP 0 (22.1%), 130 of SSP I (21.4%), 22 of SPP II (3.6%), 85 of SSP III (14%), and 236 of SPP IV (38.9%). In addition to the lesions of the supraspinatus, there were 62 (10.2%) full-thickness tears of the infraspinatus and 51 (8.4%) of the subscapularis tendon. Most of these lesions were massive tears [19], with 36 (5.9%) tears involving the posterosuperior (supra- and infraspinatus) and 15 (2.5%) the anterosuperior (subscapularis and supraspinatus) rotator cuff. Involvement of all three tendons (subscapularis, supra- and infraspinatus) was encountered in 26 (4.3%) shoulders. There were no isolated lesions of the infraspinatus, but there were 10 (1.6%) of the subscapularis tendon.

SSP 0 patients were significantly younger ($P < 0.0001$), and SSP IV patients were significantly older ($P < 0.0001$), while there was no significant difference in age between SSP I and II patients, between I and III patients or between II and III patients (Table 1). SSP 0 shoulders had CSAs significantly smaller (31.6°; $P < 0.0001$) than those of SSP II (37.0°), SSP III (37.3°) and SSP IV (38.1°) shoulders.

These differences were even more pronounced in patients with a bland trauma history and were less evident in those with a Trauma 1 or 2 history (Fig. 3).

However, there were no significant differences in mean CSA between SSP 0 and I, nor between SSP II and III patients, between SSP II and IV patients or between SSP III and IV patients. Therefore, we simplified the SSP classification into a binary system (SSP_bin), which graded those shoulders with structurally intact tendons (SSP 0 and I) into SSP_bin 0 and those with partial or full-thickness tears (SSP II to IV) into SSP_bin 1.