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Rotator cuff tears: association with acromion angulation on MRI☆

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Abstract

Objective: Using magnetic resonance imaging (MRI), evaluate the correlation of acromion angulation with thickening of the coracoacromial ligament (CAL) and narrowing of the subacromial space resulting in impingement upon the rotator cuff tendons. **Materials and methods:** Eighty-nine shoulder MRI studies performed on a 3T scanner were retrospectively analyzed by two blinded independent reviewers. Measurements of the acromion angle (delta angle), CAL thickness and distance between the CAL and humeral head were obtained. The data were categorized into two groups, delta angle less that and greater than 7.5°. The presence or absence of full thickness (FT) or near full thickness (NFT) rotator cuff tears was noted. **Results:** In group 1, the acromion angle varied from -6.8 to 6.8° (1.7±3.5°) with a CAL thickness of 0.91±0.20 mm and a subacromial distance of 6.47±0.88 mm. Group 2 acromion angle varied from 7.6° to 46.8° (18.0°±8.1°) with a CAL of 1.77±0.51 mm and a subacromial distance of 4.52±0.82 mm. The difference in CAL thickness and subacromial distance were significantly different between the two groups ($P<.001$). In Group 1, 3 out of 51 patients had a FT or NFT tear of the rotator cuff compared to 20 out of 38 in Group 2 ($P<.001$). There was no significant interobserver variability. **Conclusion:** Steep acromion angulation is associated with CAL thickening and narrowing of the subacromial space. Patients with a steep acromion angle had a statistically increased incidence of rotator cuff tears.

Keywords: Shoulder; Magnetic resonance imaging; Rotator cuff; Anatomy; Acromion

1. Introduction

Subacromial impingement and degeneration of the rotator cuff (RTC) tendons is one of the most common causes of shoulder pain and disability. The incidence of shoulder pain is approximately 11.2–19 cases per 1000 patients per year [1]. In 1972, Neer first described RTC impingement related to the anteroinferior portion of the acromion in three stages [2]. The process was described as a progression of disease beginning in younger patients ultimately resulting in RTC tears [2,3]. Subsequent studies go on to describe acromion shape, angulation and configuration in association with RTC pathology [4–6]. The anatomy and biomechanics related to subacromial impingement is a complex association between acromion angulation, the coracoacromial ligament (CAL) and the subacromial space (SAS). Previously, authors have described features of the acromion, including the type and the configuration, on both radiographic images and anatomic specimens [4–7]. Furthermore, variations in the anatomy and morphology of the CAL are associated with varying degrees of RTC degeneration in anatomic specimens [7,8]. The biomechanics likely relate to the steep acromion angle causing friction of the CAL along the bursal fibers of the supraspinatus (SST) and infraspinatus tendons (IST). The bursal surface pressures may in turn increase tension in the undersurface fibers resulting in articular surface tears of the SST and IST [9].

Most patients with persistent shoulder pain related to impingement ultimately undergo magnetic resonance

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imaging (MRI) for further evaluation. Data describing the down-sloping angulation of the acromion in association with CAL thickness, SAS narrowing and ultimate RTC deterioration has not been described. The correlation of MRI findings of acromial shape and RTC pathology has been limited due do variations in positioning, slice selection and interobserver variability [10–13].

The goal of the current study was to characterize the acromion angle with respect to RTC tears and delineate a normal/abnormal range of measurements for CAL thickness and SAS distance using MRI. The methods outlined in this study attempt to provide a standard measurement and reference pattern that is reproducible and reduces inter-observer variability. These measurements will provide a guideline for evaluating the SAS on MRI and may help guide the surgeon in treatment of patients with impingement.

2. Materials and methods

This retrospective study was performed with institutional review board approval and a waiver of patient informed consent.

2.1. Patients

A total of 89 patient exams were retrospectively reviewed. The average age was 46.3±16.4 years and ranged from 15–80 years. Females and males represented 36 and 53 of the patients, respectively.

2.2. Acromion angulation measurement (delta angle)

The acromion measurement was obtained on either T1 or PD FS coronal MRI sequences from a 3T scanner. The angle was based on the steepest point of the acromion relative to the clavicle (Fig. 1A). A line was drawn along the margin of the acromion with the reference being a horizontal line on the image.

2.3. Coracoacromial ligament thickness

The CAL thickness was obtained on either T2 FS or PD FS coronal MRI sequences from a 3T scanner. The measurement was performed at the lateral margin of the acromion at the insertion of the CAL. A vertical line was drawn at the thickest point of the insertion (Fig. 2A).

2.4. Subacromial space

The SAS distance was obtained on either T2 FS or PD FS coronal MRI sequences from a 3T scanner. A vertical line was drawn from the undersurface of the CAL at its insertion to the superior margin of the humeral head cartilage at the narrowest point on coronal images (Fig. 3A).

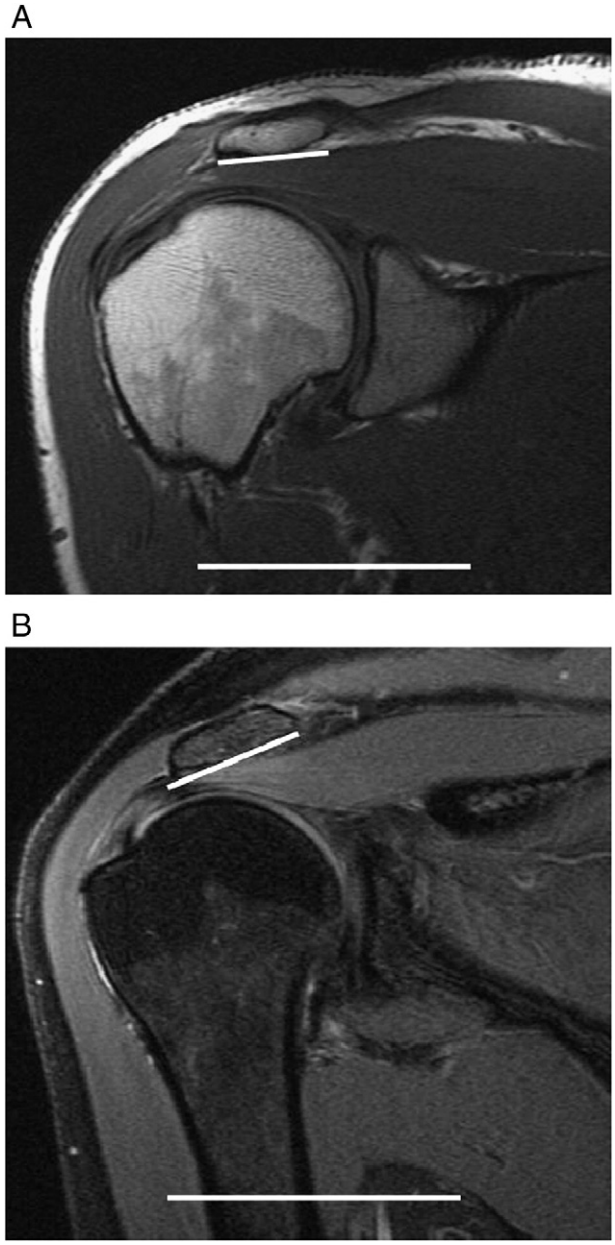

Fig. 1. The above images demonstrate normal and abnormal delta angle measurements. (A) Coronal T1 image of a right shoulder obtained on a 3T scanner. The white lines indicated the measurement method of the delta angle. The upper line was drawn along the undersurface of the acromion while a horizontal reference line was drawn on the lower portion of the image. The delta angle measured in this patient equaled 3°. (B) Coronal PD FS image of a right shoulder obtained on a 3T scanner. The delta angle measured on this exam was abnormal equaling 22°.

2.5. Study evaluation

In a blinded fashion, each of two reviewers independently evaluated a complete shoulder MRI exam performed on a 3T scanner on each patient. Reviewer 1 was a board certified musculoskeletal radiologist and reviewer 2 a radiology resident. The standard scanning protocol for most patients was COR T1, COR T2 FS, COR PD FS, SAG T2 FS, SAG