

Imaging Features and Clinical Significance of the Acromion Morphological Variations

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Abstract

The pathogenesis of rotator cuff tears is complex and chaos; however, the rotator cuff tears have been related to the morphology of the acromion. We named those variations of the acromial morphological as “Congenital and Osteal Etiological Factors”, which include the shape, lateral extension, the angle between the undersurface of the acromion and the glenoid and the distance from acromion to humeral head.

The critical area for degenerative tendinitis and tendon rupture was centered in the supraspinatus tendon and the anteroinferior of acromion was the main region of impingement. According to this theory, Neer designed the anterior acromioplasty in 1972. Bigliani et al. analyzed the shape of the acromion on lateral radiographs and found a higher prevalence of rotator cuff tears in patients with a hooked [type-III] acromion than in individuals with a curved [type-II] or a flat [type-I] acromion. The concept of Lateral Acromion Angle [LAA] was defined by Banas et al. at first, which was defined as the slope of the inferior surface of the acromion relative to the scapular glenoidplane. The acromiohumeral interval which was measured as the smallest distance from the inferior surface of the acromion to the superior aspect of the humerus. Several soft tissues pass through this arch, such as infraspinatus and supraspinatus and subacromial bursa. The concept of Acromion Index [AI] was defined by Nyffeler et al. at first, which could directly describe the lateral extension degrees of acromion. It could also be considered as the coverage degree of acromion onto the subacromial tissue.

Keywords: Infraspinatus; Subacromial bursa; Acromion index

Techniques for Taking the Views

True anteroposterior views

It is necessary to take the true anteroposterior radiograph that the scapular plane should be parallel to the X-ray cassette. Since the scapular plane rest at an angle of approximately 45 degrees to the coronal plane, the patient needs to rotate the body until the scapular plane is parallel to the X-ray cassette (Figure 1). The patient needs the forearm to be at the side of the body without abduction and with the palm facing forwards. On this position, the views could show clearly the space between the glenoid and the humeral head, the middle part of clavicle is overlapped; the fringe of the glenoid is in a line [1-6].

Anteroposterior views

If the coronal plane of the thorax parallel to the X-ray cassette, the anteroposterior view of the glenohumeral joint is obtained. In this views, the humeral head to be overlapping with the glenoid, and the outline of the glenoid is oval but not is line, the clavicle is unfolded (Figure 2).

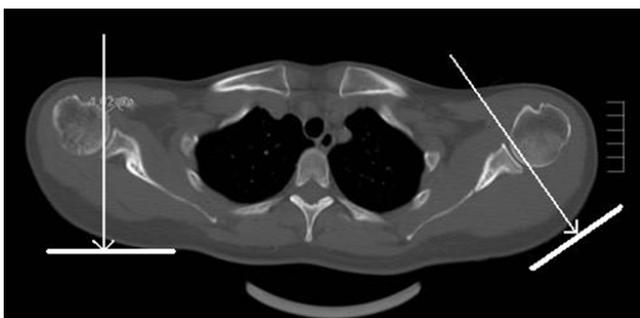


Figure 1: Note the great difference between the two angles of the x-ray beam, the placement of the cassettes, and the schematic drawings of the glenohumeral joint.

Lateral outlet views

The position of the shoulder is usually held in internal rotation. The X-ray beam parallel to the scapular plane, is directed to the cassette. On the lateral outlet view, the form of the scapular is a “Y” shape. And we can see the lateral surface of the acromion (Figure 3). Lateral outlet view of the glenohumeral joint show the humeral head well centered around the glenoid fossa.

Types of Acromion

Bigliani [2] analyzed the morphologic condition of the acromion on lateral outlet view radiographs and divided it into three types. A type I [flat] acromion had a flat outline. A type II [curved] acromion had a gentle curve. A type III [hooked] acromion had an abrupt change in the radius of curvature of the cortical undersurface (Figure 4).

Acromion index

The concept of Acromion Index [AI] was defined by Nyffeler et al. first [6], which could directly describe the lateral extension degrees of acromion. It could also be considered as the coverage degree of acromion onto the subacromial tissue. A true anteroposterior radiograph of the shoulder is necessary in measuring the acromion

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Figure 2: Those pictures come from a same patient. A is the anteroposterior view of shoulder joint and with the features that: (1) The clavicle is unfolded. (2) The shape of glenoid is a oval. (3) The humeral head to be overlapping with the glenoid. B is the true anteroposterior views of shoulder joint and with the features that: (1) The space between the glenoid to the humeral head. (2) The middle part of clavicle is overlaped. (3) The fringe of the glenoid is a line.



Figure 3: Lateral outlet view of the glenohumeral joint.



Figure 4: A. Lateral outlet view of type I acromial morphologic condition. B. Lateral outlet view of type II acromial morphologic condition. C. Lateral outlet view of type III acromial morphologic condition.



Figure 5: The radiograph shows the acromion index ($AI = GA/GH$).

index. The line “a” connected the superior and inferior osseous margins of the glenoid cavity and represented the plane of the glenoid surface. The tangent line of the lateral acromion is line ‘b’. GA is the distance from line ‘a’ to line ‘b’. GH is the distance from line ‘a’ to line ‘c’, which is the lateral tangent line of proximal humerus. The relationship between these two distances [GA/GT] was calculated and termed as the Acromion Index [AI] (Figure 5).

Acromion Coverage Index (ACI)

The concept of Acromion Coverage Index [ACI] was defined by Torrens et al. at first [7]. A true anteroposterior view was obtained for each subject. To measure the acromial coverage of the humeral head, line “a” was found which was tangential to the superior and inferior osseous margins of the glenoid cavity as same as AI in such a way that the perpendicular to this line to the lateral end of the acromion was designated as the Acromial Distance [AD]. The humeral head was considered as a circle, and the diameter perpendicular to the line “a” was identified as the Humeral Distance (HD). The ratio between Acromial Distance and Humeral Distance [AD/HD] was called the acromial coverage index (Figure 6).

Acromiohumeral interval

The true anteroposterior radiograph of the shoulder was used to measure the acromiohumeral interval [4-5]. The inferior surface of the acromion was showing in a sclerotic line on the AP radiograph. It was the first step to measure the acromiohumeral intervals that confirm the sclerotic line which was represent the “roof” of the acromion. The measurement consisted of drawing two parallel lines and measuring the distances between those lines. The line “a” was placed upon the sclerotic line, to represent the inferior surface of the acromion. The line “b” was drawn parallel to the line “a” and was tangential to the most superior point of the humeral head. The distance between line “a” and line “b” is acromiohumeral interval (Figure 7).

Lateral Acromion Angle (LAA)

A special oblique coronal MRI [1.5 tesla or 3.0 tesla] was used to

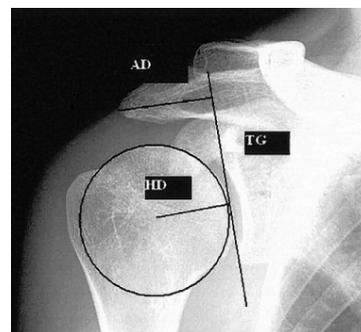


Figure 6: Lateral outlet view of type acromial morphologic condition. C. Lateral outlet view of type acromial morphologic condition.



Figure 7: The line “a” is placed upon the sclerotic line, representing the “roof” at the undersurface of the acromion. The line “b” is drawn parallel to the line “a” and tangentially to the most superior point of the humeral head.

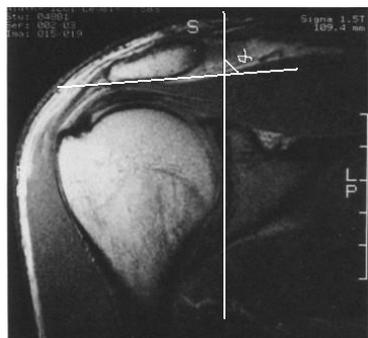


Figure 8: Lateral acromion angle was formed by intersection of line which parallel to acromion undersurface and second line which parallel to farthest lateral extension of superior and inferior bony glenoid.

measure lateral acromion angle [3]. There was no conventional angle or range but the random oblique coronal plane which cut just posterior to acromioclavicular joint and parallel to the scapular plane. On this radiograph, the supraspinatus muscle and tendon must be seen passing below the acromion. The line “a” was parallel to the furthest lateral margin of the superior and inferior bony glenoid. The line “b” was parallel to the acromion undersurface. The angle [LAA] was determined by the intersection of those lines. Nyffeler et al. proposed that there may be a correlation between the lateral acromion angle and the acromion index on the last part of his paper: “both parameters use the glenoid plane as a reference” [6] (Figure 8).

Types of Acromion According to Neer

Neer [1] pointed that the critical area for degenerative tendinitis and tendon rupture is centered in the supraspinatus tendon, and identified the anteroinferior of acromion is the main region of impingement. According to this theory, Neer designed the anterior acromioplasty. However, he did not observe the variation of acromion. Bigliani et al. [2] defined the classification of the acromion and found that type III [hooked] acromions had a higher incidence of rotator cuff tears than type I [flat] or type II [curved] acromions. Nicholson et al. evaluated 420 scapulas to determine the acromial morphologic condition [8]. They found that the distribution of acromial morphologic types was type I, [flat] 32%, type II [curved], 42%, and type III [hooked], 26%. Generally speaking, this classification was used to the predisposing factors to tear off the rotator cuff in the outpatient.

Acromion index

Nyffeler et al. [6] found that the average acromion index [and standard deviation] was 0.73 ± 0.06 in the shoulders with a full-thickness tear, 0.60 ± 0.08 in those with osteoarthritis and an intact rotator cuff, and 0.64 ± 0.06 in the asymptomatic, normal shoulders with an intact rotator cuff. Kim et al. suggest that a high AI can be one of the associated factors for progression to large-to-massive rotator cuff tears in a rotator cuff disease [9]. Howerer, Kircher et al. did not find a significant association between a low acromion index and typical signs of osteoarthritis at the shoulder [10]. The theoretical concept of a small acromion index associated with the development of osteoarthritis of the shoulder is not supported. Miyazaki et al. suggest that the acromion index can be used as a predictive factor for RCTs in the Brazilian population but not in the Japanese population [11].

Lateral Acromion Angle (LAA)

Banas et al. suggests that a significant correlation between

the lateral acromion angle and underlying rotator cuff changes as determined by means of MRI [3]. For the 100 MRI studies of the glenohumeral joints were selected in Banas et al.’s study. There was a statistically significant correlation seen between the decrease of lateral acromion angle and increased risk of rotator cuff disease. Eight shoulders which were with a full-thickness rotator cuff tears had lateral acromion angle less than or equal to 70° . The average lateral acromion angle was measured in 80° in the control group of 25 patients without symptoms. However, some variations were found in the inclination of the scapula glenoid [12-15], and the lateral acromion angle is an absolute value but is not a relative value, so its value depends upon the morphology of the acromion and the scapula glenoid.

The acromiohumeral interval

The normal acromiohumeral interval was considered as 7 to 14 mm [16-18]. Narrowing of the distance indicate the superior migration of humeral head, which has been associated with the tearing of the rotator cuff tendons, especially the supraspinatus. The tearing of supraspinatus bring about biomechanical dysfunction of the glenohumeral joint, because the supraspinatus play an important role in pressing the humeral head. Hiroshi Minagawa et al. confirm that the function of pressing would be weakened, because tear or fatty degeneration was present in one or more rotator cuff muscles that they cannot counteract the deltoid. The increase of the AHD indicating subluxation or luxation of shoulder.

The extrinsic theory of rotator cuff disease was proposed by many scholars who believed that the acromion caused mechanical attrition to the aponeurosis supraspinatus. We named those variations of the acromial morphology is “Congenital and Osteal Etiological Factors” which play subsidiary roles in diagnosing the rotator cuff injury. This study suggests that those “Congenital and Osteal Etiological Factors” may be a useful adjuvant in the evaluation of patients who thought to have or to be at risk for rotator cuff disease. Hence the introduction of those concepts is necessary. However, some factors may exist in a same patient. Therefore, a comprehensive analysis is necessary for surgeon to analyse the patients.

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