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Review Article

Anatomy Section

Shoulder Impingement and its Association with Acromial Morphology- A Review

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ABSTRACT

Shoulder with its chronic disability recognised by impingement of the rotator cuff beneath the coracoacromial arch. Varying acromial morphology revealed alterations attributable to mechanical impingement. The undersurface of the anterior part of the acromion and the front lip were always implicated. Extrinsic factors caused impingement and tendonopathy, with the anterolateral acromion 'impinging' on the superior surface of the rotator cuff. The present review clearly describes the acromial morphology and its role as extrinsic causative factor in shoulder impingement. Treatment options for confirmed impingement range from analgesics and physiotherapy to injectable therapy and, open and arthroscopic surgery. In most studies, the results of arthroscopic subacromial decompression are positive, and data suggests that, the operation minimises the occurrence of rotator cuff injuries when compared to a control group. Complete acromionectomy and lateral acromionectomy yielded dismal results, prompting researchers to investigate the undersurface of the acromion in the development of impingement syndrome. There are, however, contradictory studies discussing the role of extrinsic and intrinsic causative factors of impingement.

Keywords: Acromion process, Arthroscopy, Rotator cuff

INTRODUCTION

Shoulder is inherently unstable with wide range of movements and require bones, muscles and ligaments for support. The relatively short lever arm of the shoulder muscles operating on the substantially longer lever arm of the upper limb, often with additional load in the hand, results in extremely high loads via, the tendons and strong response forces across the joint surfaces, causing shoulder pain [1].

Impingement is due to varying morphology of acromion process resulting in 'painful shoulder'. When the arms abduct at 90° and internally rotate at 45°, the supraspinatus tendon is closest to the anterior inferior border of the acromion, and the subacromial gap width changes. Because of the reduced space, the tendon is exposed to friction, resulting in a painful arc of 60 to 120° on abduction, weakening, and a partial loss of movement in the affected shoulder. The pain worsens at night and with overhead shoulder movements, resulting in functional impairment. With the use of conventional x-rays, early detection and care of disease can assist to limit disease development and its impact on everyday life [1].

External factors such as the prominence of the anterior-inferior acromion and the development of bony spurs extending into the coraco-acromial ligament, particularly anterior degenerative spurs, were once assumed to be the cause of primary impingement of the rotator cuff tendons. Many investigations support the hypothesis that, it was solely a mechanical process caused by extrinsic wear of the bursal surface of the tendon beneath the superior arch of the acromion [2].

Seagger RM and Wallace AL mentioned that, Biglani classified acromion radiologically into three types, flat, curved and hooked depending on the morphology of acromion process [2]. According to Seagger RM and Wallace AL [2], and Neer CS [3], shoulder impingement can be studied under three stages:

Stage 1- Inflammation, oedema, and bleeding of the conjoint tendon in people under the age of 25, which is reversible, if treated, conservatively.

Stage 2- Continuation of Stage 1, although the symptoms are consistent. Patients between the age of 25-40 years are affected.

Stage 3- Affect patients more than 40 years. It includes partial or complete tear of rotator cuff due to chronic repetitive mechanical irritation to the conjoint tendon [2].

Shoulder impingement and rotator cuff tear are quite common and is treated surgically [2]. The cause is still under debate. The dispute centres on two potential causes of shoulder impingement are intrinsic degenerative alterations in the tendons and extrinsic mechanical compression caused by the acromion process. One of the important factor in shoulder impingement syndrome is morphometry of acromion process [1,2].

DISCUSSION

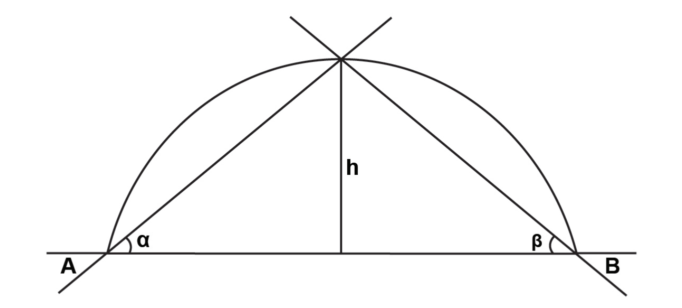
In 1972, Neer CS [3] was the first person to describe impingement. It accounts for approximately 70% of shoulder diseases.

According to the main theory for rotator cuff impingement syndrome, there are anatomical and functional contributing elements (supraspinatus, infraspinatus, teres minor and subscapularis). The anatomical causes include inclination of the acromion process along with its shape. With conditioning and fitness, exact diagnosis of pathologic lesions is challenging due to individual differences in shoulder morphology and degree of shoulder laxity. On other view, rotator cuff tears due to degenerative changes of tendon has been described in 1931, by Codman. The supraspinatus syndrome is caused by compression of the bursa and rotator cuff tendons under the acromion. Previous literature successfully reported that, treatment by anterior acromioplasty in 95% of cuff tears caused by mechanical impingement [4].

Bigliani LU et al., [5], Nicholson GP et al., [6], Shah NN et al., [7], Gill TJ et al., [8], proposed both above theories which have been supported in numerous publications. Vitale MA et al., [9], stated that there has been a substantial increase in incidence of acromioplasty in the United States, which is still the standard operative treatment for impingement lesions. As per previous reports, indication for acromioplasty is generally supported by typical changes in acromial morphology on standard radiographs [3,4,10,11-14].

Acromial Morphological Features which can be Evaluated in Impingement

Acromial type: It is determined by keeping the acromion on flat surface and measuring from anterior margin to posterior margin. As in [Table/Fig-1], 'A' represented anterior point and 'B' represented posterior point of acromion process. Two straight lines were drawn touching the anterior and posterior points of acromion process. The distance 'h' from the summit of two lines to flat surface was measured. Anterior angle was marked as 'α' and posterior angle as 'β' [15].



[Table/Fig-1]: Type of acromion depending on height, anterior and posterior angle: Shows h- height of summit of inferior border of acromion process from the flat surface, α- anterior angle and β- posterior angle.

On morphometric basis, the acromion process was characterised as:

Type I: h ≤2 mm;

If h >2 mm,

Type II: β/α <1.5

Type III: β/α>1.5 [15]

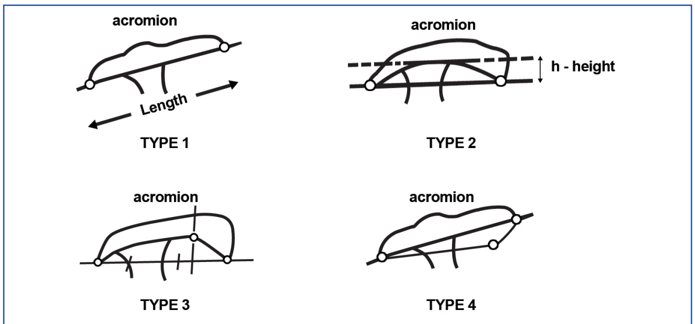
Types 2 and 3 acromions were quantitatively separated by Epstein RE et al., [16], whereas type 1 and 4 acromions were designated according to Bigliani LU et al., [11]. Types 1 and 4, as well as Types 2 and 3, are identified using the same three anatomic landmarks and a similar geometric technique Stehle J et al., [17]. According to modified Epstein classification, types were given to acromion process with following criteria [16]:

Type 1: Height that is less than or equal to 2% of acromial length.

Type 2: The highest point was above the middle third of the acromial length and the height was larger than 2% of the acromial length.

Type 3: As per Stehle J et al.,) [17] finding the highest point was above the anterior third of the acromial length and that the height was larger than 2% of the acromial length.

Type 4: The undersurface's lowest point was under the acromial length [Table/Fig-2] [17].



[Table/Fig-2]: Shows acromion process, its length and height, their relations with each other and flat surface.

A line connecting the most caudal borders of the acromial undersurface was manually drawn and its length was calculated using parasagittal MR images for acromial type assessment. With the help of two orthogonal lines, the line was then separated into three equal-length parts. After that, the angle between the anterior third and the posterior two-thirds of the acromion was calculated [18].

Angle between anterior third and posterior two third was 10° or less, it's Type 1 and if it's 11-20°, it was called Type 2.

If >20°, then angle between the posterior third and the anterior 2/3rd was further measured, if this, latter angle was 10° or less, type 3 acromion was defined and if >10°, this would be type 4 acromial shape [18].

Maximum acromial length: Distance from midpoint of posterior border to tip of acromion process [19].

Acromial slope [Table/Fig-3A]: According to Bigliani LU et al., [11] and Kitay GS et al., [20] the acromial slope (AS) measured on outlet-view radiographs. A line was drawn from the most anterior point of the inferior acromion to the midway point on the inferior acromion to determine the length. Another line is drawn from the inferior acromion's most posterior point to the same midway point. These two lines make an angle (δ) that measures AS [4].

Acromial tilt [Table/Fig-3B]: The Acromial Tilt (AT) was determined on outlet-view radiographs by Kitay GS et al., [20] and Aoki M et al., [10]. A line traced from the inferior acromion's most posterior point to its most anterior point. A second line is drawn from the inferior acromion's most posterior point to the coracoid process's inferior tip. The Acromial tilt is the resultant angle [4].

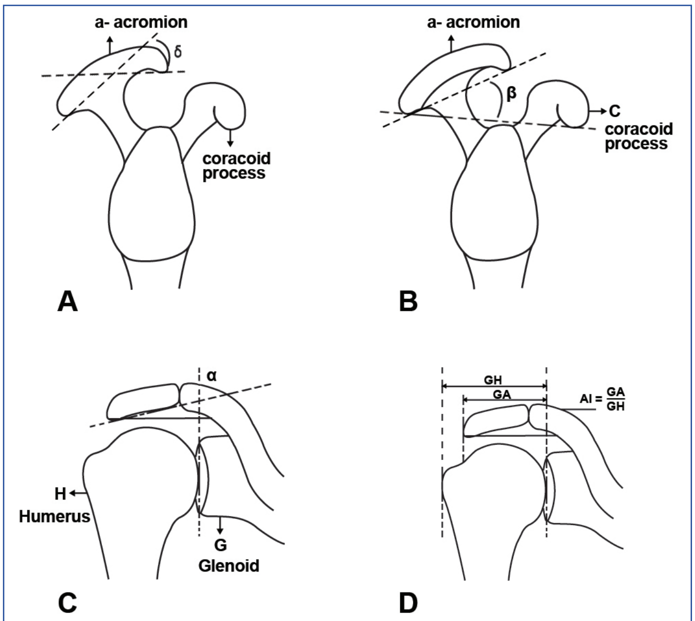
Lateral acromial angle [Table/Fig-3C]: The Lateral Acromial Angle (LAA) is measured using true anteroposterior radiographs, according to Banas MP et al. [12]. The glenoid surface is represented by a single line drawn along the superior and inferior most lateral points of the glenoid. Another line is drawn parallel to the underside of the acromion. The LAA is represented by the angle formed by these two lines [4].

Acromion index [Table/Fig-3D]: According to Nyffeler RW et al., [21], the Acromion Index (AI) measured on true anteroposterior radiographs. It was denoted by:

The distance between the glenoid plane and the acromion (GA)/ the glenoid plane and the lateral aspect of the humeral head (GH). The greater the acromion's extent, the higher the AI [4].

Acromial thickness: The widest portion of the acromion measured is Acromial thickness [19].

Acromio-humeral distance: It's the distance between the acromion's underside and the humeral head's superior surface [22].



[Table/Fig-3]: Parameters explaining the cause for impingement.
Shows A; δ- Acromial Slope, B; β- Acromial Tilt ,C; α-Lateral acromial angle, D-Acromial Index, a-Acromion process, h- Humerus, G-Glenoid cavity, A and B -Supraspinatus outlet view, C and D-Anteroposterior View

Findings of various studies are described in [Table/Fig-4] [10-12,14,20,21,23-25].

The classification of acromial morphology is still commonly utilised in clinical practise and plays a significant role in deciding whether or not to have acromioplasty. However, the measurement's general applicability and interobserver reliability remain unknown. As a result, these assessment instruments require more research and have yet to be adopted into the standard of rotator cuff evaluation [25].

S. No.	Authors	Findings
1.	Bigliani LU et al., [11]	Described a flat (type-I), curved (type-II), or hooked (type-III) acromion on outlet-view radiographs which is the most common one.
2.	Bigliani LU et al., [11], MacGillivray JD et al., [23]	Type-III acromion has been found to be associated with a higher prevalence of rotator cuff tears.
3.	Ozaki J et al., [24], MacGillivray JD et al., [23]	They found type III acromion was not associated with higher prevalence of rotator cuff tears.
4.	Bigliani LU et al., [11] and Kitay GS et al., [20]	Described the Acromial Slope (AS).
5.	Kitay GS et al., [20] and Aoki M et al., [10]	Described the Acromial Tilt (AT).
6.	Banas MP et al., [12], Tetreault P et al., [14], Nyffeler RW et al., [21]	The lateral rather than the anterior expansion of the acromion has been studied.
7.	Banas MP et al., [12]	On MRI, the frontal plane slope of the acromion was described, and individuals with rotator cuff dysfunction had a decreased Lateral Acromial Angle (LAA).
8.	Hamid N et al., [25]	Using a combination of control patients, operatively treated patients, and cadaveric subjects, showed a tight link between acromial spurs and rotator cuff disease.
9.	Nyffeler RW et al., [21]	The acromial index, a new acromial assessment to determine the amount of lateral acromial extension, was described as being closely associated with rotator cuff.

[Table/Fig-4]: Explains the various findings from different authors [10-12,14,20,21, 23-25].

When interpreting opaque shadows on radiographs, association of subacromial enthesophytes with acromial morphology and rotator cuff tears should be borne in mind. The location and size of enthesophytes, acromial shape and rotator cuff status will aid the clinician to decide the type of surgery. Type III found to be predominant in impingement syndrome. Cuff tears involving total tears induce radiological Acromiohumeral Distance (AHD) of <6 mm [22]. Impingement and rotator cuff tears are more common in people with a low lateral acromial angle and a considerable lateral extension of the acromion. Only patients with rotator cuff injuries had an excessively hooked anterior acromion and a LAA of less than 70° [4].

The key anatomical aspects of the scapula that can restrict the space available for the supraspinatus tendon appear to be lateral acromial overhang, lateral coracoids angle, and coraco-acromion arch angle. These features can be thought of as predisposing anatomical factors for supraspinatus tears, to which intrinsic and extrinsic secondary compression variables (age-related acromial osteophyte) can be added. Degenerative alterations are more directly linked to the acromion's slope and length, as well as, the arch's height. The type III acromion is involved in 62-66% of rotator cuff rupture instances [22]. To refine the link between rotator cuff tears and the key anatomical features of the supraspinatus outlet, a clinical anatomy investigation based on CT or MRI definition of the subacromial canal in specimens, with known supraspinatus tendon damage status would be required [4].

CONCLUSION(S)

Knowledge of the present review includes scope for further investigation to incorporate these measurement tools into the main stream of rotator cuff evaluation. It also might benefit the Orthopaedician during surgical repair around joint. It is also helpful to anthropologists on evaluation of acromion and useful to forensic experts in determination of gender from acromial morphology.

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