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## Correlative MRI study of acromion morphology and associated rotator cuff tears

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### Abstract

**Background:** Shoulder pain is frequently caused by subacromial impingement or rotator cuff injuries and forms the major indications for presurgical evaluation using MRI. Rotator cuff tears are caused by either internal degenerative changes or extrinsic compression of the acromion on the rotator cuff tendons. Reduction in subacromial space and abnormal acromial morphologies contribute to rotator cuff damage. Hence identifying these acromial abnormalities forms an essential part of evaluation since these forms the main indication for corrective acromioplasty.

**Methods:** This institution-based MRI study was evaluated in three groups as follows: Group 1-15 patients with rotator cuff tear; Group 2-15 patients with subacromial impingement; Group 3-10 controls without subacromial impingement pathology and rotator cuff tear and assessed for type of acromion, Lateral Acromial Angle (LAA), Acromion Index (AI), and Acromio-humeral Interval.

**Results:** The type II Acromion showed significant association with rotator cuff tear and subacromial impingement followed by Type III and Type I respectively in our study. However, Type II acromion is relatively commoner in the control study and showed 26.92%, subacromial impingement showed 30.7% and rotator cuff tear showed 42.31%. The distribution of Lateral Acromial Angles differed significantly between the three groups. In comparison to controls, patients with low lateral acromial angle had significant association with subacromial impingement and rotator cuff tears. The age distribution of the Acromion Index differed significantly between the three groups with higher predilection to rotator cuff tear and impingement as age advanced and higher acromial index. Between the three groups, the subjects with low acromio-humeral distance had significant association with rotator cuff tears and impingement.

**Conclusions:** Low lateral acromial angle, larger acromial index, and smaller acromio-humeral interval are related with a higher incidence of subacromial impingement and rotator cuff tears on MRI assessment of the shoulder.

**Keywords:** Acromion type, lateral acromial angle, rotator cuff tear, acromial index, acromio-humeral interval

### Introduction

#### Background

The acromion process is a posterior shoulder landmark generated by the scapular spine's extension. Subacromial impingement syndrome and rotator cuff tear can be caused by a change in the shape of the acromion <sup>[1]</sup>. One of the most prevalent causes of chronic shoulder discomfort and an indication for MRI assessment of the shoulder in adults is rotator cuff dysfunction <sup>[2]</sup>. Both internal and external factors contribute to it. Supraspinatus hypertrophy and greater tuberosity abnormalities are two intrinsic variables. Mechanical impingement by the coracoacromial arch is one of the recognized extrinsic causes <sup>[3]</sup>.

Despite numerous studies pointing to extrinsic impingement as the primary cause of rotator cuff illness, the involvement of the acromion remains unknown. The acromion morphology, which is frequently examined on conventional plain radiographs using the five commonly used parameters of acromial type, acromial slope, acromial tilt, lateral acromial angle, and acromial index, is linked to the pathophysiology of Rotator cuff tear <sup>[4]</sup>. On a plain radiograph in supraspinatus outlet view, however, imaging the acromion and distinguishing the hooked from the non-hooked acromion with anterior spurs is challenging <sup>[5, 6]</sup>.

The shape of acromion, as well as other acromial morphological variables such as the acromio-humeral distance, lateral acromial angle, and acromial index, can be assessed using magnetic resonance imaging (MRI). These factors are thought to have an impact on the rotator cuff's health <sup>[7, 8]</sup>.

The goal of the study was to use MRI to identify the morphological properties of the acromion and there association to the rotator cuff tears and impingement syndrome.

## Methods

The research was carried out at Sree Mookambika Institute of Medical Sciences, Kulasekharam, from December 2020 to February 2021 in the Department of Radiodiagnosis.

The study comprised of Group 1:-15 patients with rotator cuff tears (supraspinatus partial or full), Group 2:- 15 patients with subacromial impingement, and Group 3:-10 healthy controls with no subacromial pathology and rotator cuff tears. All participants who had a shoulder MRI were included in the study. Patients having previous shoulder surgery, fractures and/or dislocations, infections, or malignancies were excluded. All of the study participants signed a written informed consent form.

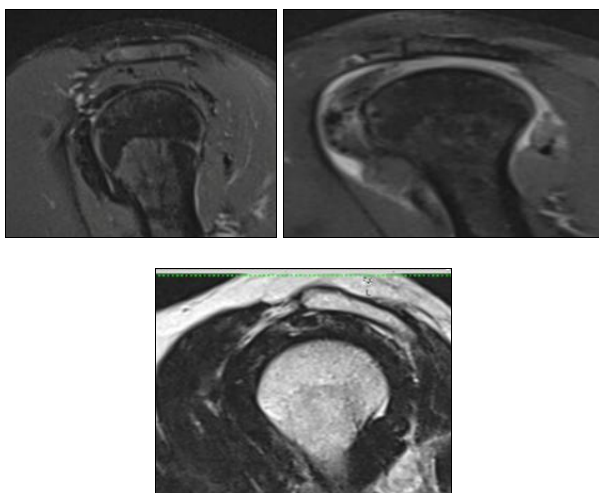
The study participants were evaluated with shoulder MRI on Siemens Magnetom Essenza 1.5T MRI with a dedicated 8 channel shoulder coil. Patients were put in a supine position with their arms on the sides of their bodies in partial external rotation. Following the localizer images, coronal oblique, sagittal oblique, and axial images were obtained. Sequences - Axial, Coronal, sagittal-T2WI, PDFS.

For best viewing of the supraspinatus tendon, the coronal oblique plane was chosen parallel to the tendon's course. The images were interpreted by radiologist with 14 years' experience in the musculoskeletal imaging. The association of subacromial impingement and rotator cuff tears were analysed with respect to following acromial morphological parameters: - Acromial Type, Acromial Lateral angle, Acromial index and Acromio humeral distance

### 1) Acromial type

Sagittal oblique MR images were used to analyze the morphology of the acromion<sup>9</sup> (Refer to Figure 1a to 1d).

- Type I: Flat
- Type II: Curved, paralleling humeral head
- Type III: Anterior hooked
- Type IV: Convex undersurface.

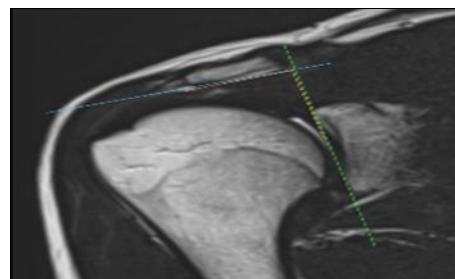


**Fig 1(a-c):** Types of Acromial Shape. Type 1 or Flat (a), Type II or Curved (b), Type III or Anterior Hooked (c)

### 2) Acromial Lateral Angle

On coronal oblique MR images, the lateral acromial angle was calculated. Along the superior and inferior most lateral points of the glenoid, a straight line was drawn. On the underside of the acromion, another straight line was drawn parallel to it. The Lateral Acromial angle was defined as the angle formed by these two lines<sup>10</sup> (Refer to Figure 2a). A lower limits of normal lateral acromial angle with cut off of

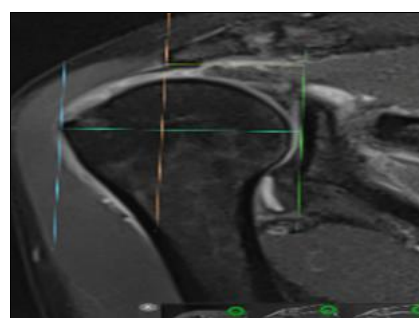
around 70-75 degrees<sup>[17]</sup>. figure2a)



**Fig 2(a):** Acromial Lateral Angle

### 3) Acromion Index

The glenoid plane to the acromion (GA) was split by the glenoid plane to the lateral aspect of the humeral head (GH). On coronal oblique images, it was calculated. (See Figure 2b for further information.) Normal value was <0.7. if it is > 0.7 then it was clinically important<sup>[17]</sup>.

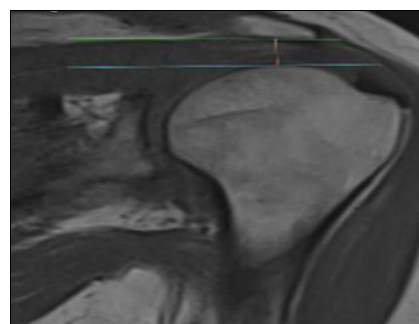


**Fig 2(b):** Acromion Index

### 4) Acromiohumeral distance

In coronal oblique images, it is the shortest distance in millimetres (mm) between the undersurface of the acromion and the superior surface of the humeral head. (Figure 2c)

- >12 mm: shoulder dislocation; inferior subluxation (e.g. from joint effusion)
- 9-10 mm (range 8-12 mm): normal
- 6-7 mm: thinning of supraspinatus tendon
- <6 mm: supraspinatus tear



**Fig 2c:** Acromiohumeral distance

On MRI, a rotator cuff injury was diagnosed. Visualization of a complete defect in any rotator cuff muscle tendon was the most specific indicator of a full thickness rotator cuff tear. According to the area of the tendon that was aberrant, partial thickness tears were divided into three categories: articular-sided tears, bursal-sided tears, and interstitial tears.

### Analytical Statistics

The data was imported into a Microsoft Excel spreadsheet and analyzed with the SPSS 22 software. Frequencies and proportions were used to represent categorical data. For qualitative data, the Chi-square test was utilized as a significance test.

For quantitative and qualitative data, the ANOVA (Analysis of Variance) test of significance was used to determine the mean difference between more than two groups.

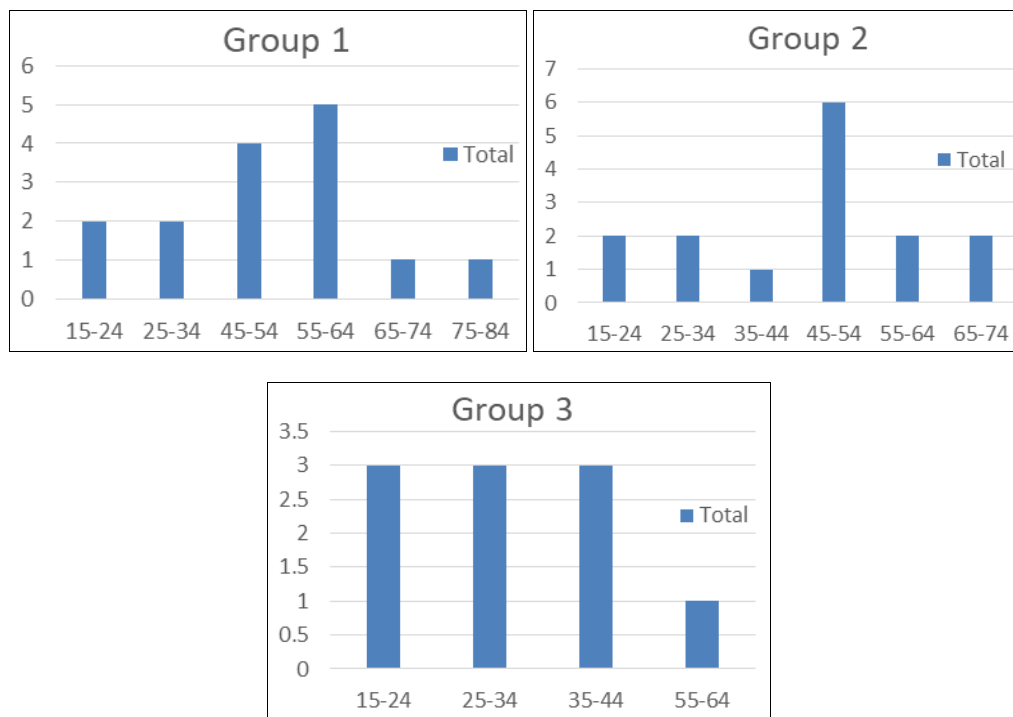
Data visualization: MS Excel and MS Word were used to

create a variety of graphs, including a bar diagram. After applying all statistical principles, a p value (probability that the result is true) of 0.05 was judged statistically significant. Statistical Analysis Software

The data was analysed using MS Excel and IBM SPSS Statistics version 22 (IBM SPSS Statistics, Somers, NY, USA).

### Results

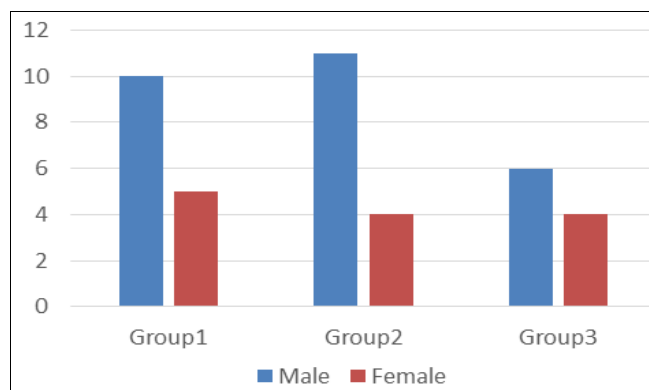
#### Age wise distribution



**Fig 3:** The age distribution of the three groups differed significantly

**Table 1:** Distribution based on sex

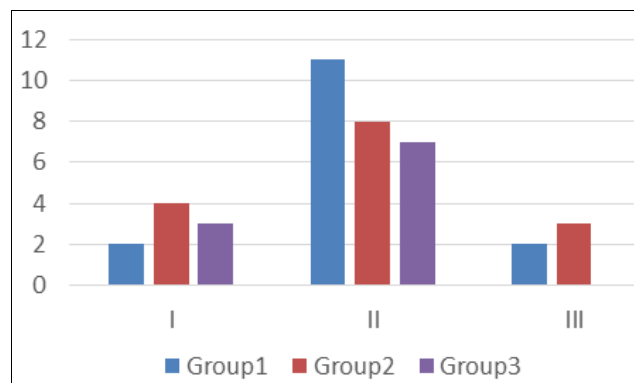
	Group1	Group2	Group3
Male	10(37.04%)	11(40.74%)	6(22.22%)
Female	5(38.46%)	4(30.77%)	4(30.77%)



**Fig 4:** Distribution by sex

**Table 5:** Distribution by Acromial Type

Distribution by Acromial Type			
Type	Group1	Group2	Group3
I	2 (22.2%)	4(44.4%)	3(33.3%)
II	11(42.3%)	8(30.7%)	7(26.9%)
III	2(40%)	3(60%)	0(0%)



**Fig 5:** Distribution by acromial type

Among rotator cuff tears (group 1) 22.2% of Type I Acromion, 42.3% of Type II Acromion and 40% of type III acromion was found.

Among subacromial impingement (group 2) 44.4% of Type I Acromion, 30.7% of Type II Acromion and 60% of type III acromion was found.

Among control without rotator cuff tears and subacromial impingement pathology (group 3) 33.3% of Type I Acromion, 26.9% of Type II Acromion and 0% of type III acromion was found.

Between the three groups, there was no significant difference in Acromion Type.

In contrast to 20% of impingement and tear patients, none of the controls exhibited type III acromion.

### Acromial index distribution

Acromial index of more the 0.6 occurred in rotator cuff tears (group 1) and sub acromial impingement (group 2).

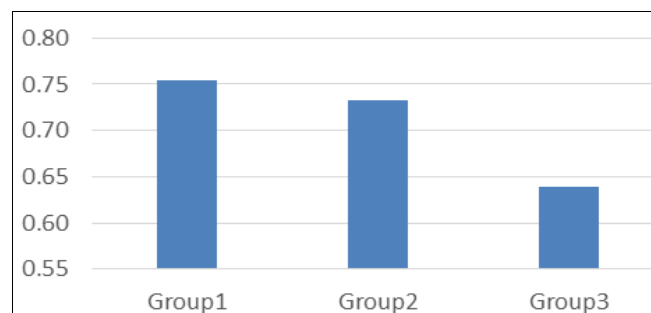


Fig 6: acromial index

### Lateral acromial angle

Subjects in Group 1 had a mean Lateral Acromial Angle of  $69.73 \pm 2.1$  degrees, Group 2 had a mean Lateral Acromial Angle of  $74.6 \pm 3.48$  degrees, and Group 3 had a mean Lateral Acromial Angle of  $81.50 \pm 3.54$  degrees. The distribution of Lateral Acromial Angles differed significantly between the three groups.

An angle of  $<70$  degrees, occurred in patients with rotator cuff tears and acromial impingement.

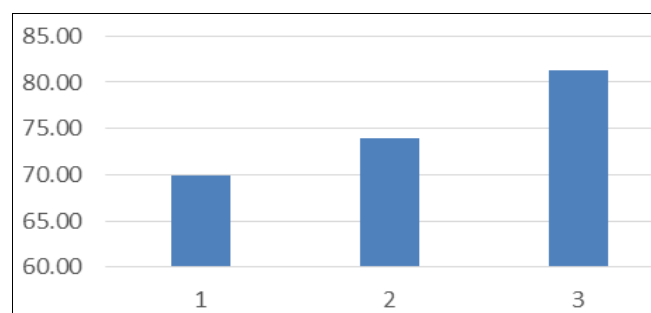


Fig 7: LAA

### Acromio-humeral interval

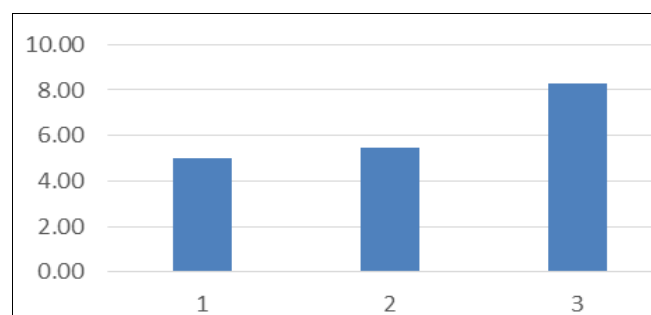


Fig 8: AHI

Acromio-humeral interval of  $< 6$ mm occurred in group 1 and group 2 patients.

Subjects in Group 1 had an Acromio-Humeral Interval of  $5.13 \pm 1.39$  cm, Group 2 had an Acromio-Humeral Interval of  $5.31 \pm 1.21$  cm, and Group 3 had an Acromio-Humeral Interval of  $8.44 \pm 1.47$  cm. Between the three groups, there was a significant variation in Acromio-Humeral Interval distribution.

Table 6: Mean distribution

Mean	acromial index	LAA	AHI
Group1	0.75	69.84	4.99
Group2	0.73	73.97	5.43
Group3	0.64	81.28	8.30

Between the three groups, there was a substantial difference in Acromial Index distribution. However, there was no significant difference between rotator cuff tear and impingement individuals. Subjects in Group 1 had an Acromio-humeral Interval of  $4.99 \pm 1.39$  cm, Group 2 had  $5.31 \pm 1.21$  cm, and Group 3 had  $8.34 \pm 1.47$  cm. Between the three groups, there was a substantial difference in Acromio-humeral Interval distribution.

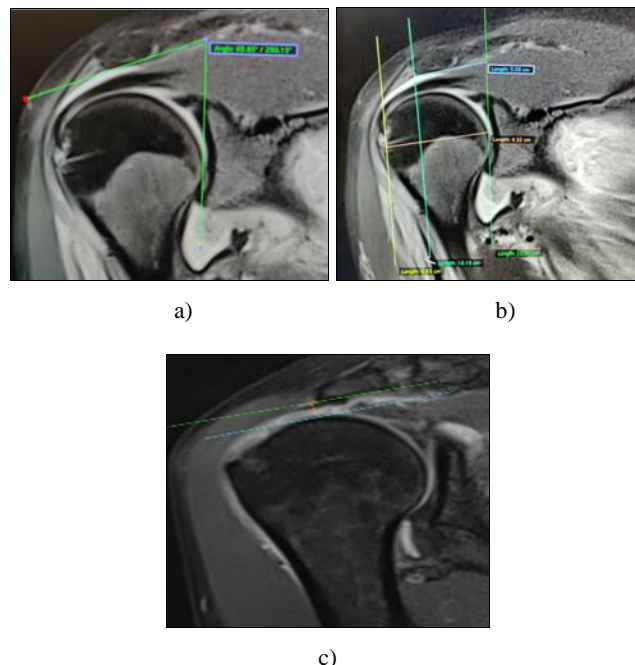


Fig 9: Image of 55 year old male with pain in shoulder Showing Measurement of Lateral Acromion Angle - 69(a), Measurement of Acromion Index-0.7 (b), Measurement of Acromio-humeral Interval-5.9 (c)

### Discussion

Rotator cuff tear pathophysiology is a controversial subject. The morphology of the acromion part of the scapula plays a significant role in this. Several studies have been carried out to back up this claim. There was no statistically significant difference in the incidence of acromial morphologies between the patient and control groups in our investigation. According to Bigliani *et al.*, none of the controls exhibited a type-III acromion, compared to 60% of impingement and 40% of cuff-tear cases. There were no significant statistical differences in the prevalence of Type III Acromion in the impingement and rotator cuff-tear groups. In line with the findings of Banas *et al.*, we found no significant association between acromion type and patient age [11]. Rotator cuff tears are usually related with type III (Hooked) and type II (curved) acromion, which can cause tractional injury to the tendon. Type-I (flat) acromion, on the other hand, usually has a little role in rotator cuff illness and is best treated conservatively [12]. We discovered a substantial link between lateral acromion angle and rotator cuff disorders using MRI in our investigation, which was verified by Banas *et al.* [9]. Tetreault *et al.* also discovered that a narrower angle



between the acromion and the glenoid surface is linked to a higher risk of rotator cuff injury <sup>[13]</sup>. They hypothesized that a smaller angle would restrict the volume available for shoulder joint content and put undue strain on the rotator cuff. Only cuff tears were found to have an exceptionally low LAA of less than 70° in our study and that of Banas *et al.* According to Kamesh G *et al.* difference in type of group, lateral acromial angle between three groups are similar to ours, none of the controls had a type-III acromion, compared to 60% of impingement and 40% of cuff-tear cases and Type III acromion is risk factor for group 1 and group 2 pathologies. There were no significant statistical differences in the prevalence of Type III Acromion in the impingement and rotator cuff-tear groups <sup>[17]</sup>.

The findings of Nyffeler *et al.* and Torrens *et al.* on the acromion index (AI) are similar to ours.

When compared to subacromial impingement and cuff-tear patients, controls had significantly lower AI values. There was no statistically significant difference between patients with impingement and those with cuff tears. Hamid *et al.* found no significant difference in AI values between participants with rotator cuff injuries and controls, which contradicts our findings <sup>[14]</sup>. As a result, the AI can distinguish between healthy shoulders and shoulders with subacromial disease, but not between impingement and cuff tears. LAA could be used to perform the latter differentiation. The patients with subacromial impingement were similar in age to the controls in this study, however the patients with rotator cuff tears were older. As the incidence of rotator cuff tears rises with age, this conclusion was expected <sup>[15]</sup>.

## Conclusions

Rotator cuff tears have a complicated etiology that is linked to the anatomy of the acromion. Low lateral acromial angle, higher acromial index, and smaller acromio-humeral interval are morphologic features of the acromion that are linked to a higher prevalence of subacromial impingement and rotator cuff tears and may be assessed by MRI. These factors are crucial because the morphology of the acromion is used to determine whether or not acromioplasty is necessary a lateral acromial angle of less than 70° was found only in people who had rotator cuff injuries.

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