Assessment of Acromial Morphology in Association with Rotator Cuff Tear and Impingement Syndrome Using Magnetic Resonance Imaging

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ABSTRACT

BACKGROUND

Subacromial impingement and rotator cuff tears are common causes of shoulder pain and indications for MRI shoulder. They often require surgical treatment. The underlying causes for the same are still poorly understood. Both intrinsic degenerative changes in the rotator cuff tendons and extrinsic compression by the acromion are responsible for rotator cuff tears. Certain acromial morphologies contribute to rotator cuff injury by decreasing the subacromial space. Identification of these acromial morphology becomes important as indications for acromioplasty are based on both clinical symptoms and changes in acromial morphology on MRI.

METHODS

Type of acromion, Lateral Acromial Angle (LAA), Acromion Index (AI) and Acromiohumeral Interval were measured on MRI from 15 patients with supraspinatus tears, 15 patients with subacromial impingement, and 10 controls without subacromial pathology.

RESULTS

There was no significant difference in the type of Acromion between the three groups. None of the controls had type III acromion, in contrast to 20% of subacromial impingement and rotator cuff tear patients. There was significant difference in Lateral Acromial Angle distribution between three groups. Low acromion angles were found in patients with rotator cuff tear in comparison to controls and patients with subacromial impingement. An angle of <70 degrees, occurred only in patients with rotator cuff tears (n=2). There was significant difference in Acromial Index distribution between the three groups. However, the difference between rotator cuff tear and impingement patients did not reach statistical significance. There was significant difference in Acromiohumeral Interval distribution between the three groups. Significantly low values were found in patients with rotator cuff tear. Mean age of controls (46.00 ± 7.50 years) and patients with subacromial impingement (50.14 ± 7.62 years) were similar, but those of controls and rotator cuff tear patients (60.07 ± 6.25 years) and impingement and rotator cuff patients were different.

CONCLUSIONS

Morphologic parameters of acromion such as low lateral acromial angle, higher acromial index and lesser acromiohumeral interval are associated with higher prevalence of subacromial impingement and rotator cuff tears and can be measured using MRI. An extremely hooked anterior acromion with lateral acromial angle of less than 70° occurred only in patients with rotator cuff tears.

KEYWORDS

Acromion Type, Lateral Acromial Angle, Acromial Index, Acromiohumeral Interval, Rotator Cuff Tear

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BACKGROUND

The acromion process is a posterior shoulder landmark, formed as an extension of the scapular spine. It articulates with the clavicle and gives origin to deltoid and trapezius muscles.[1] Variation in the shape of the acromion can result in subacromial impingement syndrome and rotator cuff tear (RCT).[2] Rotator cuff disorder is one of the most common cause of chronic shoulder pain and indication for MRI evaluation of shoulder in adults. It results from a combination of intrinsic and extrinsic factors. Intrinsic factors include Supraspinatus hypertrophy and greater tuberosity abnormality. Recognized extrinsic factors include mechanical impingement by coracoacromial arch.[3]

Although many studies have been carried out regarding extrinsic impingement as the primary etiology of rotator cuff disease, the role of acromion is still unclear. The pathogenesis of RCT is related to the acromion morphology which is routinely assessed through the five commonly used parameters on standard plain radiographs including the acromial type, acromial slope, acromial tilt, lateral acromial angle and acromial index.[4] However it is difficult to image the acromion and distinguish the hooked from the non-hooked acromion with anterior spurs on a plain radiograph in supraspinatus outlet view.[5,6] The magnetic resonance imaging (MRI) helps in evaluation of shape of acromion and other acromial morphological factors including the acromiohumeral distance, and lateral acromial angle and acromial index. These factors are suggested to influence the status of the rotator cuff.[7,8]

The study intended to identity the morphological characteristics of acromion associated with rotator cuff tear and impingement syndrome using MRI.

METHODS

This study was carried out in the period from December 2018 to February 2019 in the Department of radiodiagnosis. 15 patients with rotator cuff tears (partial or complete), 15 patients with subacromial impingement and 10 controls without subacromial pathology were included in the study. Inclusion criteria included all patients undergoing MRI of shoulder. The exclusion criteria included patients with previous surgery, fractures and/or dislocation, infections or tumors of the shoulder. Written informed consent was obtained from all study subjects. The study subjects underwent MR Imaging of shoulder using Siemens magneto Avanto model 1.5T MRI machine. When imaging the shoulder with MRI, patients were placed in a supine position with their arms on the sides of the body in partial external rotation. Initially, the localizer images were obtained, followed by coronal oblique, sagittal oblique and axial images. The coronal oblique plane was selected parallel to the course of the supraspinatus tendon itself for optimal visualization of the tendon. The various acromial morphological factors including the acromial shape, acromial thickness, acromiohumeral distance, and lateral acromial angle and acromial index were evaluated and their relationship to subacromial impingement and rotator cuff tears was assessed.

1) Acromial Type

The shape of acromion was assessed on sagittal oblique MR images.[9] (Refer to Figure 1a to 1c). Type I – Flat, Type II – Curved, Type III – Anteriorly hooked.

2) Lateral Acromial Angle

Lateral acromial angle was calculated on coronal oblique MR images. A straight line was drawn along the superior and inferior most lateral points of the glenoid. Another straight line was drawn parallel to the acromion under surface. The angle between these two lines represented the LAA.[10] (Refer to Figure 2a).

3) Acromion Index

The distance from the glenoid plane to the acromion (GA) was divided by the distance from the glenoid plane to the lateral aspect of the humeral head (GH). It was calculated on coronal oblique images. (Refer to Figure 2b)

4) Acromiohumeral Distance

It is the shortest distance, in millimetres (mm), between the under surface of the acromion and the superior surface of the humeral head measured in coronal oblique images. (Refer to Figure 2c).

The rotator cuff tear was diagnosed on MRI. The most specific sign of a full thickness rotator cuff tear was visualization of a complete defect in any tendon of rotator cuff muscles. Partial thickness tears were broadly classified into 3 different types according to the portion of the tendon that was abnormal: articular-sided tears, bursal-sided tears, and interstitial tears.

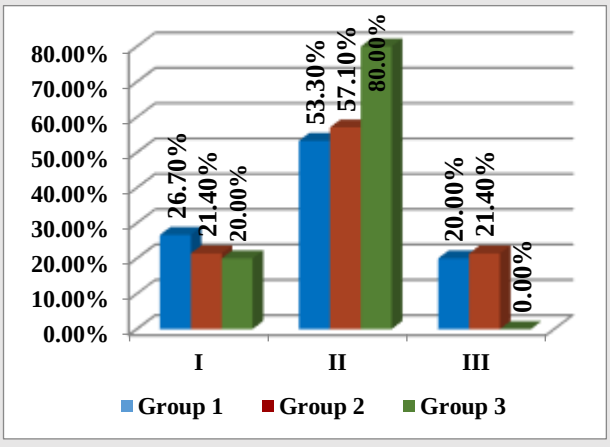
Statistical Analysis

Data was entered into Microsoft excel data sheet and was analysed using SPSS 22 version software. Categorical data was represented in the form of Frequencies and proportions. Chi-square test was used as test of significance for qualitative data. Continuous data was represented as mean and standard deviation. ANOVA (Analysis of Variance) was the test of significance to identify the mean difference between more than two groups for quantitative and qualitative data respectively. Graphical representation of data: MS Excel and MS word was used to obtain various types of graphs such as bar diagram. p value (Probability that the result is true) of <0.05 was considered as statistically significant after assuming all the rules of statistical tests.

Statistical Software

MS Excel, SPSS version 22 (IBM SPSS Statistics, Somers NY, USA) was used to analyse data.

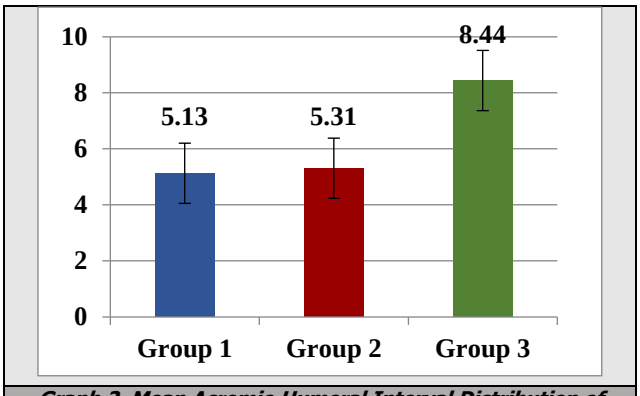
RESULTS



Graph 1. Acromial Type Distribution of Subjects Between Three Groups

In Group 1, 26.7% had Type I, 53.3% had Type II and 20% had Type III Acromian. In Group II, 21.4% had Type I, 57.1% had Type II and 21.4% had Type III Acromian and in Group III, 20% had Type I, 80% had Type II and 0% had Type III Acromian. There was no significant difference in Type of Acromian between three groups.

None of the controls had type III acromion, in contrast to 20% of impingement and tear patients.



Graph 2. Mean Acromio Humeral Interval Distribution of Subjects Between Three Groups

Mean Acromio Humeral Interval of subjects in Group 1 was 5.13 ± 1.39 cm, in Group 2 was 5.31 ± 1.21 cm and in Group 3 was 8.44 ± 1.47 cm. There was significant difference in Acromio Humeral Interval distribution between three groups.

	Lateral Acromial Angle (Degree)		P value
	Mean	SD	
Cuff Tear (Group 1)	75.73	3.10	
Impingement (Group 2)	79.64	3.48	<0.001*
Control (Group 3)	81.50	3.54	
Total	78.62	4.06	

Table 1. Mean Lateral Acromial Angle Distribution of Subjects Between Three Groups

Mean Lateral Acromial Angle of subjects in Group 1 was 75.73 ± 3.10, in Group 2 was 79.64 ± 3.48 and in Group 3 was 81.50 ± 3.54 degree. There was significant difference in Lateral Acromial Angle distribution between three groups.

An angle of <70 degrees, occurred only in patients with rotator cuff tears (n = 2)

		Acromial Index		P value
		Mean	SD	
Group	Cuff tear (Group 1)	0.75	0.04	<0.001*
	Impingement (Group 2)	0.73	0.03	
	Control (Group 3)	0.66	0.03	
	Total	0.72	0.05	

Table 2. Mean Acromial Index Distribution of Subjects Between Three Groups

Mean Acromial Index of subjects in Group 1 was 0.75 ± 0.04, in Group 2 was 0.73 ± 0.03 and in Group 3 was 0.66 ± 0.03. There was significant difference in Acromial Index distribution between three groups. However the difference between rotator cuff tear and impingement patients did not reach statistical difference.

Mean age of subjects in Group 1 was 60.07 ± 6.25 years, in Group 2 was 50.14 ± 7.62 years and in Group 3 was 46.00 ± 7.50 years. There was significant difference in age distribution between three groups.

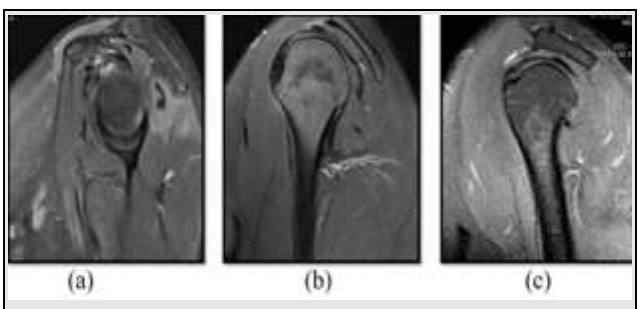


Figure 1(a-c). Types of Acromial Shape. Type 1 or Flat (a), Type II or Curved (b), Type III or Anterior Hooked (c)

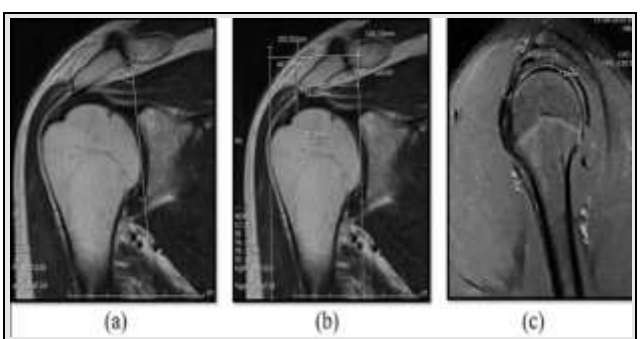


Figure 2a-c. T2 Coronal Oblique Showing Measurement of Lateral Acromion Angel (a), T2 Coronal Oblique Showing Measurement of Acromion Index (b), PDFS Sagittal Oblique Image Showing Measurement of Acromiohumeral Interval (C)

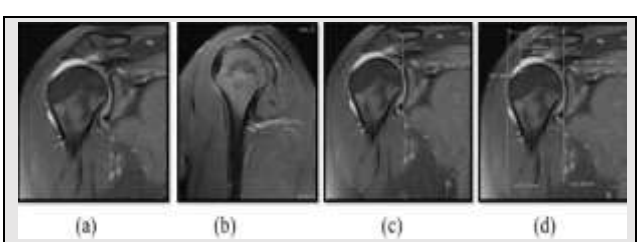


Figure 3(a-d). A 59 Year Old Female Patient with Left Shoulder Pain. PDFS Coronal Oblique (a) Showing Complete Tear of Supraspinatus Tendon. PDFS Sagittal Oblique (b) Showing Type II Acromion and PDFS Coronal Oblique Images (c, d) Showing Low Lateral Acromion Angle (76°) and High Acromial Interval (0.7)

Figure 4 (a-d). A 42 Year Old Male Patient with Right Shoulder Pain. PDFS Coronal Oblique (a) Showing Subacromial Impingement with Reduced Acromiohumeral Interval (5.7 mm). PDFS Sagittal Oblique (b) Showing Type II Acromion and PDFS Coronal Oblique Images (c, d) Showing Low Lateral Acromion Angle (70°) and High Acromial Interval (0.7)

There was significant difference in Acromial Index distribution between three groups. However, the difference between rotator cuff tear and impingement patients did not reach statistical difference. Mean Acromiohumeral Interval of subjects in Group 1 was 5.13 ± 1.39 cm, in Group 2 was 5.31 ± 1.21 cm and in Group 3 was 8.44 ± 1.47 cm. There was significant difference in Acromiohumeral Interval distribution between three groups.

DISCUSSION

The pathogenesis of Rotator cuff tear is a controversial topic. The acromion portion of the scapula and its morphology plays a important role in it. Several studies have been conducted to substantiate the same. In our study, there is no significant difference in the incidence of acromial shapes between the patient group and the control group (P = 0.561). None of the controls had a type-III acromion according to Bigliani et al. in comparison to 20% in the impingement and cuff-tear patients. Type III Acromion was common in both impingement and rotator cuff-tear groups without any statistical differences. We did not find any significant correlation between acromion type and age of the patient similar to the study conducted by Banas et al.[11] Type-III (Hooked) and type-II (curved) acromia are commonly associated with Rotator cuff tear and may cause tractional damage to the tendon. On the contrary, Type-I (flat) acromia usually have an insignificant involvement in rotator cuff disease and may be best treated conservatively.[12]

In our study we found a significant correlation between Lateral acromion angle and rotator cuff diseases by MRI, which was confirmed by the study conducted by Banas et al.[9] Tetreault et al. also concluded that a smaller angle between the acromion and the glenoid surface is associated with increased risk for rotator cuff tear.[13] They postulated that a smaller angle would reduce the volume available for the content of the shoulder joint and impose detrimental pressure on the rotator cuff. In our study and in that conducted by Banas et al, an extremely low LAA of less than 70° only occurred in cuff tears (n = 2). Lateral acromial angles were significantly different between only type-III acromial shape and the control group.

Regarding the acromion index (AI), the findings by Nyffeler et al and Torrens et al are similar to our study. Significantly lower AI values were seen in controls when compared to subacromial impingement and cuff-tear patients. We did not find a statistical significant difference between impingement patients and cuff-tear patients. Contrary to our results, Hamid et al did not find significant difference in AI values between subjects with rotator cuff tears and controls.[14] Thus it can be concluded that the AI can help differentiate between healthy shoulders and shoulders with subacromial pathology - but not between impingement and cuff tears. This latter differentiation could be done using LAA.

In the present study, the patients with subacromial impingement were of similar age in comparison to controls, but the patients with rotator cuff tears were older. This finding was expected as the incidence of rotator cuff tears increases with age.[15]

CONCLUSIONS

The pathogenesis of rotator cuff tear is complex and is related to the morphology of acromion. Morphologic parameters of acromion such as low lateral acromial angle, higher acromial index and lesser acromiohumeral interval are associated with higher prevalence of subacromial impingement and rotator cuff tears and can be measured using MRI. These parameters play an important role, as indication for acromioplasty is based on acromion morphology. An extremely hooked anterior acromion with Lateral acromial angle of less than 70° occurred only in patients with rotator cuff tears.

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