Original Article

Acromion Morphology and Morphometry in the Light of Impingement Syndrome and Rotator Cuff Pathology

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Abstract

Introduction: Acromion process of the scapula and the subacromial space plays an important role in shoulder impingement syndrome and rotator cuff pathology. The aim is to study the morphological and morphometric parameters of the acromion process of human dry scapula in the South Indian population for its relevance in shoulder impingement syndrome and rotator cuff pathology. **Material and Methods:** Seventy adult unpaired dry scapulae (35 right and 35 left) of unknown age, gender, and without deformity were studied. The various shapes of acromion process were identified. Parameters such as acromioglenoid (AG) distance, coracoglenoid (CG) distance, coracoacromial (CA) distance, and height of the coracoacromial arch (HtCAA) were measured using a digital vernier caliper. The data were statistically analyzed. **Results:** The three types of acromion process observed were Type I flat in 57.14%, Type II curved in 40%, and Type III hooked in 2.86%. The mean ± standard deviation of AG distance was 24.9 ± 3.7 mm, CG distance was 22.7 ± 4.2 mm, AC distance was 30.9 ± 5.4 mm, and HtCAA was 19.2 ± 2.7 mm. A significant difference was observed with respect to AG (P = 0.04) and CG (P = 0.0007) between both sides of the scapula. **Discussion and Conclusion:** Knowledge about the common variant and morphometric dimensions of acromion process can aid to better understanding and planning for the treatment of rotator cuff pathology due to impingement syndrome.

Keywords: *Acromion morphology, morphometry, rotator cuff pathology, shoulder impingement syndrome*

Introduction

Scapula is a flat, triangular bone lying on the posterolateral aspect of chest wall. The processes of the scapula include the spinous process and its continuation, the acromion, and the coracoid. The tip of the acromion and the lateral border of the coracoid are bridged by the coracoacromial (CA) ligament.

The acromion along with coracoid process and the CA ligament forms the protective CA arch over the shoulder joint. The underneath subacromial space contains the tendons of rotator cuff muscles and biceps brachii. Any factor leading to reduction in the subacromial space can produce shoulder impingement syndrome. Structural abnormalities of the CA arch have been noted to reduce this space.[1] The morphological variant of acromion process plays a key role in this regard. Accordingly, the acromion process has been classified into three different types based on the degree of concavity of its under surface as Type I flat, Type II curved, and Type III hooked by Bigliani *et al.* (1986).[2] This classification system has been considered to be one of the dominant diagnostic tools for shoulder impingement syndrome and rotator cuff pathologies. Farley *et al*. also described significant clinical correlation of CA arch anatomy in rotator cuff pathologies.[3] The importance of the subacromial space in impingement syndrome was also shown by Sperner.[4]

Several authors all over the world studied the morphological variants and morphometric parameters of the acromion in different population.[5-10] These parameters have shown to alter the anatomy of the CA arch to a variable extent. Hence, a detailed knowledge about the morphology and the morphometry of the acromion is required for the orthopedicians while treating cases of shoulder impingement syndrome and rotator cuff pathology.

Material and Methods

This study was conducted in the Department of Anatomy, Christian Medical College,

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Vellore, after obtaining ethical clearance and approval from the Institutional Review Board. Seventy unpaired dry adult human scapulae (35 right and 35 left) of unknown age and gender, available in the department were studied. Scapula with deformed acromion process, coracoid process, and supraglenoid tubercle (SGT) due to fracture or bony mass was excluded from the study.

Morphology of acromion process

For the observation of morphology of acromion and morphometric measurements, the position of dry scapula was fixed with the help of bench vises. The various shapes of the acromion were noted by observing the inferior surface of the acromion from the lateral aspect and were classified as three types as Type I (flat), Type II (curved), and Type III (hooked) based on the classification by Bigliani *et al*. for both sides.[2] The most common type was identified for each side.

Morphometric parameters of the acromion

For morphometric parameters, the bony landmarks such as the tip of acromion, the tip of coracoid process, and the SGT were identified and marked. All these measurements were done using a Sliding Digital Vernier Caliper (Robust, Germany) with an accuracy of up to 0.01 mm. The following parameters were studied.

a. Acromioglenoid (AG) distance: Distance between the tip of the acromion and the SGT
b. Coracoglenoid (CG) distance: Distance between the tip of the coracoid process and the SGT
c. CA distance: Distance between the tip of coracoid process and the tip of acromion process. The CA ligament was represented using a white thread extending between the coracoid process and acromion
d. Height of the CA arch (HtCAA): To measure the HtCAA, the midpoint of the CA distance was identified and marked on the white thread. The vertical distance between this point and the SGT was measured. This HtCAA represented the underneath subacromial space.

The data were entered in the Microsoft Excel 2010 sheet and statistically analyzed using Stata Statistical Software: Release 13 (StataCorp., College Station, TX: StataCorp LP, USA). The incidence for the most common type on both sides of the dry scapula was identified. The mean, standard deviation, and range were calculated for each of the above-said morphometric parameters. The comparison between these morphometric measurements was made between the sides of the unpaired specimens using two-sample *t*-test. $P < 0.05$ was considered statistically significant.

Results

Shape of the acromion

The most common type of the acromion observed in the current study was Type I or flat [Figure 1] in 57.14% and Type II or curved [Figure 2] in 40% of cases, and the least common was the Type III, i.e., hooked [Figure 3], in 2.85% of cases [Table 1].

Morphometric parameters of the acromion

The mean distance from acromion to SGT was 24.9 ± 3.7 mm (range 18.07–35.3 mm), coracoid to SGT was 22.7 ± 4.2 mm (range 14.18–34.4 mm), acromion to coracoid process was 30.9 ± 5.4 mm (range 13.32–41.8 mm), and HtCAA was 19.2 ± 2.7 mm (range 13.75–25.3 mm) [Table 2].

Comparison of the morphometric parameters between both sides of scapula

The mean distance from acromion to SGT was 25.81 ± 3.36 mm on the right side and was 24.01 ± 3.88 mm on the left side. There was a significant difference observed between the AG distance ($P = 0.04$) of either side.

The mean distance from coracoid process to SGT was 21.06 ± 3.22 mm on the right side and was 24.40 ± 4.5 mm on the left side. There was a significant difference observed between the CG distance of either side ($P = 0.0007$).

Figure 1: Flat acromion process

Table 1: Comparison of the shape of the acromion on both right and left scapula

Shape	Right (*n*=35)	Left (*n*=35)	Total (*n*=70)
Flat (I)	21 (60)	19 (54.28)	40 (57.14)
Curved (II)	13 (37.14)	15 (42.85)	28 (40)
Hooked (III)	1 (2.85)	1 (2.85)	2 (2.85)

Table 2: Morphometric parameters of the acromion

Variables (distance)	Mean±SD (mm)	Range (mm)
Acromion to SGT	24.9±3.7	18.07-35.3
Coracoid to SGT	22.7±4.2	14.18-34.4
Acromion to coracoid process	30.9±5.4	13.32-41.8
Midpoint of CAL to SGT	19.2±2.7	13.75-25.3

SD=Standard deviation, SGT=Supraglenoid tubercle, CAL=Coracoacromial ligament

The mean distance from acromion to coracoid process was 29.61 ± 3.88 mm on the right side and was 32.15 ± 6.44 mm on the left side. There was no significant difference observed between the CA distances (P = 0.05) of either side.

The mean distance of the HtCAA was 19.32 ± 2.98 mm on the right side and was 19.09 ± 2.50 mm on the left side. There was no significant difference observed between the HtCAA (P = 0.73) of either side [Table 3].

Discussion

The present study was done in dry adult human scapula of unknown age and gender. The morphological variants and the morphometric parameters of the acromion were studied in detail in the present study. Comparison of the present study was done with the similar previous studies done on different populations by various authors and comparison is shown in Table 4. There were differences noted between the current and previous studies.

Shapes of the acromion

In the present study, Type I (flat) was the most common, while Type II (curved) was the most common type which has been reported in the previous studies done by Getz *et al*., Natsis *et al*., Paraskevas *et al*., Schetino *et al*., Naidoo *et al*., Gosavi *et al*., El-Din and Ali, Saha *et al*., Kumar Panigrahi and Mishra, Singroha *et al*., Vinay and Sivan, and Ravindranath *et al*.[1,5,6,8-16] There were differences also reported in the incidence of the type of acromion on both sides. In the present study, Type I was more on the right side with Type II being more prevalent on the left side. The incidence of Type III was found to be equal on both sides. Previous studies have documented the Type III to be more common on the left side in a study done by Singroha *et al*. in the Indian population[16] [Table 4]. This reveals that there exist racial differences and also there are chances for the occurrence of the shoulder impingement syndrome on either right or left depending on the handedness of the individual.

There were gender differences reported in the incidence of the different types of the acromion. Type I was common in females in the present study whereas Type III (hooked) was common in males in the previous studies done by Getz *et al*. and Paraskevas *et al*. and Type III was found to be common in females in the study done by Singroha *et al*.[1,14,16] In the present study, gender and age were unknown.

Nicholson *et al*. showed that these variants in the morphology of the acromion were described to play an important role in the impingement syndrome.[18] Type III was found to be the most important predisposing factor for impingement syndrome in the study done by Epstein *et al*.[19] The incidence of rotator cuff tears was found to be higher in patients with Type II and Type III acromion in the radiological study done by Worland *et al*., 2003.[20] The incidence of hooked type was found to be higher in patients with rotator cuff tears in the study done by Balke *et al*., 2013.[21]

Figure 2: Curved acromion process

Figure 3: Hooked acromion process

Table 3: Comparison for the morphometric parameters between right and left scapula

Parameters	Right		Left		*P*
	Mean±SD (mm)	Range (mm)	Mean±SD (mm)	Range (mm)	
Acromion to SGT	25.81±3.36	20.17-34.4	24.01±3.88	18.07-35.27	0.04
Coracoid to SGT	21.06±3.22	14.18-28.01	24.40±4.5	16.5-34.4	0.0007
Acromion to coracoid process	29.61±3.88	21.68-36.77	32.15±6.44	13.32-41.78	0.05
Midpoint of CAL to SGT	19.32±2.98	14.22-25.29	19.09±2.50	13.75-24.26	0.73

SGT=Supraglenoid tubercle, CAL=Coracoacromial ligament, SD=Standard deviation

Table 4: Comparison of the shapes of the acromion of human dry scapula of present study with the previous studies

Observers	Population	Sample size	Results (%)
Natsis *et al*., 2007[5]	Greece	423	Type II (curved)-239 (56.5) Type I (flat)-51 (12.1) Type III (hooked)-122 (28.8) Type IV (convex)-11 (2.6)
Saha *et al*., 2016[11]	Indian	200	Type II (curved)-122 (61) Type I (flat)-70 (35) Type III (hooked)-8 (4)
Naidoo *et al*., 2015[12]	African	120	Type I (flat)-34.6 Type II (curved)-51.1 Type III (hooked)-14
Gosavi *et al*., 2015[13]	Indian	127	Type I (flat)-17 (13.38) Type II (curved)-104 (81.88) Type III (hooked)-06 (4.72)
Kumar Panigrahi and Mishra, 2017[10]	Indian	297	Type I (flat)-76 (25.59) Type II (curved)-69 (56.90) Type III (hooked)-52 (17.51)
Paraskevas *et al*., 2008[1]	Greece	88	Type I (flat)-23 (26.1) Type II (curved)-49 (55.6) Type III (hooked)-16 (18.1) Type I was common in females and Type III was common in males
Getz *et al*., 1996[14]	_	394	Type I (flat)-90 (22.8) Type II (curved)-270 (68.5) Type III (hooked)-34 (8.6) Type I was common in females and Type III was common in males
Ravindranath *et al*., 2018[9]	Indian	130	Type I (flat)-12 (9.23) Type II (curved)-116 (89.23) Type III (hooked)-2 (1.54)
El-Din and Ali 2015[6]	Egypt	160	Type I (flat)-43 (26.88) Type II (curved)-93 (45.62) Type III (hooked)-24 (15)
Schetino *et al*., 2013[15]	Brazil	57	Type I (flat)-3 (5.6) Type II (curved)-33 (57.89) Type III (hooked)-21 (36.84)
Singroha *et al*., 2017[16]	Indian	100	Type I (flat)-9 Type II (curved)-48 Type III (hooked)-43 was common in females and on the left side
Vinay G and Sivan S, 2017[8]	Indian	164	Type I (flat)-61 (37.1) Type II (curved)-78 (47.5) Type III (hooked)-25 (15.2)
Sinha *et al*., 2018[17]	Indian	164	Type I (flat)-15 (24.59) Type II (curved)-30 (49.18) Type III (hooked)-16 (26.22)
Present study, 2018	Indian	70	Type I (flat)-40 (57.14) Type II (curved)-28 (40) Type III (hooked)-2 (2.85)

The morphological parameters of the acromion thus contribute significantly to the anatomy of the CA arch and subacromial space, thus playing an important role in the impingement syndrome and rotator cuff pathology..

Coracoacromial distance

The mean value of the CA distance was similar to the study done by Ravindranath *et al*.[9] The mean value of the CA distance on the left side was higher than the right side in the present study, but it was not statistically significant. This was similar to the study done by Mansur *et al*. in the Nepalese population and Vinay G and Sivan S in the South Indian Population[8,22] [Table 5]. However, in the current study, the mean value of CA distance was found to be significantly lesser than the study done by Kumar Panigrahi and Mishra[10] and Sinha *et al*.[17] This also shows that there exist racial differences. This lesser CA distance has clinical relevance in shoulder impingement syndrome as it is one of the contributing factors in the formation of the CA arch.

Acromioglenoid distance

The mean value of the AG distance was similar to the study done by Ravindranath *et al*. and Kumar Panigrahi and Mishra.[9,10] The mean value of the AG distance on the right side was higher than the left side (P = 0.04) in the present study. This was similar to studies done by Vinay G and Sivan S, Ravindranath *et al*., and Kumar Panigrahi and Mishra on the Indian Population.[8-10] This statistically significant difference might be due to the higher mobility of the right side in right-handed persons as mentioned by Kumar Panigrahi and Mishra.[10]

Table 5: Comparison of the morphometric parameters of the acromion process of human dry scapula of the present study with the previous studies

	Population	Sample size	CA AG distances (mm)
Kumar Panigrahi and Mishra, 2017[10]	Indian	297	CA-37.49±4.87 (R) 37.23±4.48 (L) AG-26.39±2.64 (R) 24.20±3.14 (L)
Paraskevas *et al*., 2008[1]	Greece	88	CA-28.1 (range-21-39) AG-17.7 (range-13-20)
Saha *et al*., 2016[11]	Indian (North)	200	CA-28.4326±5.30 AG-26.2145±3.33
El-Din and Ali, 2015[6]	Egypt	160	CA-31.34±3.64 AG-27.39±3.01
Ravindranath *et al*., 2018[9]	Indian (South)	130	CA-29.83±4.74 AG-26.18±3.14
Vinay G and Sivan S, 2017[8]	Indian (South)	164	CA-34.05 33.81±4.65 (R) 34.34±5.3 (L) AG-29.79±4.04 (R) 30.36±4.14 (L)
Naidoo *et al*., 2015[12]	African	120	CA-25.63±4.3 (R) 24.24±4.4 (L) AG-20.96±3.2 (R) 20.88±4.5 (L)
Mansur *et al*., 2012[22]	Nepalese		CA-26.63±3.55 (R) 39.39±5.28 (L) AG-31±3.70 (R) 31.97±3.97 (L)
Sinha *et al*., 2018[17]	Indian	61	CA-35.94±5.58 AG-28.28±3.84
Present study, 2018	Indian (South)	70	CA-30.9±5.4 29.61±3.88 (R) 32.15±6.44 (L) (P=0.05) AG-24.9±3.7 mm 25.81±3.36 (R) 18.07-35.27 (L) (P=0.04)

CA=Coracoacromial, AG=Acromioglenoid, R=Right, L=Left

Table 6: Comparison of the height of the coracoacromial arch of the present study with the previous studies

Observers	Population	Sample size	Mean (mm)	*P*
Tapasa *et al*.[10]	Indian (North)	297 145 R	21.01±4.06 (R)	<0.004
		152 L	19.52±3.00 (L)	
Present study	Indian (South)	70 35 R	19.32±2.98 (R)	0.73
		35 L	19.09±2.50 (L)	

R=Right, L=Left

Height of the coracoacromial arch

The mean value of the HtCAA was similar to the study done by Kumar Panigrahi and Mishra.[10] The mean value of the HtCAA was similar on both sides in the present study, and it was not statistically significant. This was different compared to the study done by Kumar Panigrahi and Mishra where there was a significant difference between the sides and the right side had a higher value than the left side and it was statistically significant ($P < 0.004$)[10] [Table 6].

Coracoglenoid distance

The mean value of CG distance was lower than the AG distance in the present study. There was statistically significant difference observed between the right and left sides of the scapula ($P = 0.007$) in the current study population. There are no previous studies available to compare this value.

Conclusion

In the present study, the Type I (flat) was the most common among the three morphological variants of the acromion process of scapula. The AG and CG distances which contribute to the architecture of the CA arch and the subacromial space were significantly higher on the right side as compared to the left side. The differences between the present study and the other studies in these morphometric parameters show that there are racial and regional variations. This knowledge will be helpful for the orthopedicians in diagnosing and planning treatment procedures for patients with impingement syndrome and rotator cuff pathology.

Limitation

Age and gender of the scapulas were not known. The sample size was less in the present study.

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Conflicts of interest

There are no conflicts of interest.

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