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RESEARCH ARTICLE

Morphometric study of the acromion process of adult human scapulae and its clinical application in Orissa population

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ABSTRACT

Background: Morphometric study of the acromion process of scapula is an important diagnostic tool for various diseases of shoulder joint. It is implicated in subacromial impingement syndrome and the pathogenesis of rotator cuff diseases. Furthermore, morphometric analysis of acromion process would be helpful for surgeons while performing surgical procedure on shoulder joint. **Aims and Objectives:** The aims of this study were to record the morphometric values of the acromion process of scapula and establish the relationship between various parameters, that is, length, breadth, and thickness of acromion process, mean acromiocoracoid distance, and mean acromioglenoid distance. **Materials and Methods:** The study was carried out on 30 dry human scapula of unknown age and sex. The acromial length,acromial breadth,acromiocoracoid distance and the length of the scapula were measured with the help of digital vernier caliper. Different types of acromion process were also noted and photograph of all the specimen has been taken with the help of camera. **Results:** The mean length of acromion process on the right and left scapulae was 40.11 mm and 41 mm, respectively. The mean breadth of the acromion process on the right and left scapulae was 26.36 mm and 23.86 mm, respectively. The mean acromioglenoid distance on the right and left scapulae was 17.10 mm and 17.67 mm, respectively. The mean acromiocoracoid distance on the right and left scapulae was 25.67 mm and 24.3 mm, respectively. Type 1 (flat) acromion was observed in 20.5% and Type 2 (curved) acromion was observed in majority (73.9%) and Type 3 (hooked) in 6%. **Conclusion:** The results of the present study may be of help to clinician to understand and treat various shoulder and also helpful for surgeons while performing surgical procedures on shoulder joint.

Keywords: Acromion,Scapula,Impingement,Rotator cuff diseases

BACKGROUND

The scapula is a large, triangular bone that lies over the posterolateral chest wall, covering parts of the second to seventh ribs with a vertical long (craniocaudal) axis. It has costal and dorsal surfaces, superior, lateral and medial borders, inferior, superior, and lateral angles, and three processes, the spine its continuation – the acromion, and coracoid process.

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The acromion projects forward, almost at the right angles, from the lateral end of the spine, with which it is continuous. The lower border of the crest of the spine becomes continuous with the lateral border of the acromion at the acromial angle. The medial border of the acromion is short and is marked anteriorly by a small, oval facet directed upward and medially, for articulation with the lateral end of the clavicle. The lateral border, tip, and upper surface of the acromion can all be felt through the skin without difficulty.

The acromion is subcutaneous over the dorsal surface, being covered only by skin and superficial

fascia. The inferior aspect of the acromion is relatively smooth forms a protective arch over the shoulder joint together with the coracoacromial ligament and the coracoid process. The tendon of supraspinatus passes below the overhanging acromion and is separated from it and from deltoid by the subacromial bursa.

Acromion process of scapula has been classified by many researchers into three types: Type 1 flat, Type 2 curved, and Type 3 hooked. Variation of acromion has been associated with sub-acromial impingement syndrome and rotator cuff tear. Variation in shape is important clinically, especially for shoulder arthroplasty.

Determination of sex using scapular measurement is very useful in medicolegal cases and natural disasters. Scapular measurements can be used for manufacturing prosthetics. The dimensions of scapula are important in the case of rotator cuff diseases, shoulder arthroplasty, and in recurrent shoulder dislocation.

Figure 1: Scapular length

MATERIALS AND METHODS

Thirty adult dry human scapulae were included in the study, of which 14 were of the left side and 16 were of the right side. The study was conducted in Hi Tech Medical College and Hospital, Rourkela, Orissa.

Study design

Descriptive study

The parameters related to scapula as a whole, acromion process and glenoid cavity were measured using Vernier calipers.

They were as follows:

1. Length of scapula in millimeter is taken as the distance between the summit of the superior angle and inferior angle [Figure 1]
2. Length of acromion process in millimeter is the distance between the tip and the posterior border of acromion process [Figure 2]
3. Breadth of acromion is the distance between the medial and lateral borders at the midpoint of acromion process [Figure 3]
4. Thickness of acromion process was measured at the anterior part [Figure 4]

Figure 2: Acromion length

5. The acromiocoracoid distance is the distance between the tip of acromion process and tip of coracoid process [Figure 5]
6. The acromioglenoid distance was measured as the distance between the tip of acromion process and supraglenoid tubercle [Figure 6].

The above data were then statistically analyzed using SPSS software. Descriptive statistics such as percentage, mean, and standard deviation were used to analyze the data obtained.

Using Pearson correlation coefficient values, the relationship between various variables have been tabulated.

Figure 3: Acromion breadth

Figure 4: Acromion thickness

Figure 5: Acromiocoracoid distance

RESULTS

In the present study, the length of the acromion process of the right scapulae varies from 30.6 mm to 46.2 mm with an average of 40.11 mm [Table 1] and that of the left scapulae varies from 36.2 to 47 mm with an average 41 mm. The breadth of the acromion process of the right scapulae varies from 20 mm to 33.4 mm with an average of 23.36 mm and that of the left scapulae varies from 18 mm to 29.4 mm with an average 23.86 mm [Table 2]. The acromiocoracoid distance ranges from 18.5 mm to 32.8 mm with an average of 25.67 mm on the right side and 17.5–39.2 mm with an average of 24.3mm on the left side [Table 3].

The acromioglenoid distance varies from 12.6 mm to 21 mm with an average distance of 17.10 mm and from 13 mm to 25.2 mm with an average distance of 17.66 mmm on the right and left, respectively [Table 4].

Table 1: Length of acromion process

Parameter	Right	Left
Number	16	14
Range	30.6–46.2 mm	36.2–47 mm
Mean	40.11 mm	41 mm
Standard deviation	4.24	5.13

Table 2: Breadth of acromion process (*n*=30)

Parameter	Right	Left
Number	16	14
Range	20–33.4 mm	18–28.4 mm
Mean	26.36 mm	23.86 mm
SD	3.21 mm	2.99 mm

Table 3: Acromiocoracoid distance (*n*=30)

Parameter	Right	Left
Number	16	14
Range	18.5–32.8 mm	17.5–39.2 mm
Mean	25.67 mm	24.03 mm
SD	4.4 mm	4.77 mm

Table 4: Acromioglenoid distance (*n*=30)

Parameter	Right	Left
Number	16	14
Range	12.6–21 mm	13–25.2 mm
Mean	17.10 mm	17.67 mm
SD	2.54 mm	2.68 mm

The length of the right scapulae varies from 30.6 mm to 46.2 mm with an average of 40.11mm and that of the left scapulae varies 36.2–47 mm with an average of 41 mm [Table 5]. The acromian thickness varies from 3.9 to 11.3mm of(R) scapula with an average of 6.42 mm and that of left scapula with an average of 7.41mm [Table 6] respectively Type 1 (flat) acromion process was observed in 20.5%, Type 2 (curved) was observed in 73.5% [Figure 7], and Type 3 (hooked) in 6%. The relationship between variables using Pearson correlation coefficient values was done. With increase in the length of scapula, there is corresponding increase in the length of acromion, acromiocoracoid, and acromioglenoid distance.

DISCUSSION

During the evolution of the upper extremity, the scapula more than any other bone of the shoulder girdle reflects momentous alterations that have been brought about by increased functional demands of a prehensile limb. The most significant scapular change is that the pronograde forms disclose a long narrow scapula, while, in orthograde, it becomes broader. There was also a gradual increase in the spine of scapula and the acromion process during development from the pronograde to the orthograde. This change is due to the progressive distal migration of the point of insertion of the deltoid muscle with acquisition of a free limb.[4]
The high prevalence of impingement syndrome in modern humans may be partly related to the shape acquired by the scapula throughout evolution. The distinctive characteristic noted is the lateral orientation of glenoid cavity, wide acromion that projects laterally above a horizontally oriented glenoid cavity and a narrow coracoacromial arch. The slope of acromion is steeper, which is responsible for narrower subacromial space. These features may explain in part the pathogenesis of impingement syndrome in humans.[5] In 1931, Codman reported that degenerative changes of the tendon initiate rotator cuff tears.[6] Later on, Neer, in 1983, stated that 95% of cuff tears are caused by mechanical impingement and reported success treatment by anterior acromioplasty.[7] The indication of acromioplasty is based on clinical evolution of the patient, supported by typical changes in acromial morphology on standard radiographs. The most common classification is the one by Bigliani *et al*., describing a flat (Type 1), curved (Type-2), or hooked (Type-3)

Table 5: Length of scapula

Parameter	Right	Left
Number	16	14
Range	110–137.99 mm	108.3–140.3 mm
Mean	127.33 mm	129.10 mm
SD	10.05 mm	9.9 mm

Table 6: Acromion thickness

Parameter	Right	Left
Number	16	14
Range	3.9–11.3 mm	4.2–10.1 mm
Mean	6.42 mm	7.41 mm
SD	1.87	1.32

Figure 6: Acromioglenoid distance

Figure 7: Acromion process Type 2 curved

acromion on the outlet view radiograph and found the prevalence as Type 1 (18.6%), Type 2 (42%), and Type 3 (38.6%). The rotator cuff tears were commonly associated with Type 3.[8] Bigliani *et al*. explained that different acromial shapes are likely to develop due to both genetic and acquired causes. Age is acquired cause that has been positively correlated with progression from flat to curved or hooked acromia.[9]

Paraskevas *et al*. found the mean length and width of the acromion process as 4.61 cm and 2.23 cm, respectively. They reported the incidence of acromion types as Type 1 (26.1%), Type 2 (55.6%), and Type 3 (18.1%). The mean value of the acromion-coracoid distance was 2.81 cm. The mean value of acromioglenoid distance was 1.77 cm and the mean value of scapular length was 14.76 cm.[10] Singh *et al*. reported the values as 4.61 cm of mean length and 2.32 cm of mean width, respectively. The incidence of acromion type was as follows: Type 1 (26.1%%), Type 2 (55.6%), and Type 3 (38.8%). Acromiocoracoid and acromioglenoid distance were 3.75 cm and 2.7 cm, respectively. They also found the mean value of scapular length as 14.67 cm (right) and 14.57 cm (left).[11] Similar study done by Coskun *et al*. who reported the acromial length as 4.47 cm, acromion width as 3.2 cm, and acromion-coracoid distance as 1.78 cm.[12] Sitha *et al*. observed the values of mean length and width as 4.01 cm and 3.2 cm, respectively.[13] Vinay and Sivan found the mean value of acromial length and width as 4.24 cm and 2.65 cm, respectively. The mean acromiocoracoid distance was 3.40 cm and acromioglenoid distance was 3.01 cm, the prevalence of acromion was Type 1 (37.1%), Type 2 (47.5%), and Type 3 (15.2%).[14] Mansur *et al*. had reported that the mean length of acromion process of the right scapula was 4.67 cm and that of the left side was 4.55 cm. The mean width of the acromion was 2.66 cm on the right side and 2.72 cm on the left side. They observed the mean values of acromiocoracoid distance on the right and left side as 3.90 cm and 3.19 cm on the left side.[3] Nweke *et al*. reported the length of acromion process as 4.4 cm (right) and 4.3 cm (left) and breadth as 2.4 cm (right) and 2.3 cm (left). Acromiocoracoid distance was 3.9 cm (right) and 4 cm (left). Acromiocoracoid distance was 3.9 cm (right) and 4 cm (left). Acromioglenoid distance was 3.01 cm and 3.03 cm on the right and left side, respectively.[15]

Edelson and Taitz, in their study, concluded that the length and slope of the acromion process were closely related with degenerative changes. Increased degenerative change was related with increased length of the acromion process and the length, in turn, was connected to the shape of the acromion process.[16]

Singroha *et al*. reported high incidence of Type 2 (curved) followed by Type 3 (hooked) and very low incidence of Type 1 (flat) scapulae.[17] Yazici *et al*., in their study, found Type 1 (22.5%), Type 2 (70%), and Type 3 (5%).[18] Shah *et al*. concluded the frequency as Type 1 (17%) and Type 2 (83%).[19] Farley *et al*. proposed a classification which included a fourth type of acromion which is concave downward. The incidence was small (1.6–13.3%) and is not related with rotator cuff pathology.[20] Natsis *et al*. quoted that subacromial impingement syndrome and rotator cuff tear were common in Type 3 acromion due to the presence of enthesophytes.[21] Collipol *et al*. quoted that the acromion morphology according to Epstein *et al*. appears to have a prediction value to determine the success of conservative medical treatment in some cases and the need for surgery in patients with joint impingement. Acromion of hooked type was observed with 2 times greater frequency in patients with rotator cuff impingement syndrome.[22] Sangiampong *et al*. quoted that difference in the morphology of acromion and the presence of anterior acromial spur and inferior acromioclavicular osteophytes decreases the subacromial space, leading to impingement.[23]

In the present study, the mean length of the acromion process was observed to be 40.11 mm and 41 mm on the right and left scapulae which did not show much variation with other studies. Mean breadth of acromion was 26.36 and 23.86 mm on the right and left side, respectively. Other studies also reported similar values, except that it was higher in the study of Sitha *et al*. in Thais.[13] Acromiocoracoid distance and acromioglenoid distance were almost similar to the previous study. However, in the Turkish study done by Coskum *et al*.,[12] the acromiocoracoid distance was 1.78 cm and in the Greek study done

by Paraskevas *et al*., the acromioglenoid distance was noted as 1.77 cm.[10] When compared to the present study, these studies showed lesser values. Scapular length in the present study data was lower than the studies of Paraskevas *et al*.[10] and Singh *et al*.[11] in the present study. Type 1 (flat) was seen in 22.5%, Type 2 followed by Type 1, and very low incidence of Type 3 scapulae was observed in the present study which is similar to the results obtained by Paraskevas *et al*.,[10] Sing *et al*.,[11] Yazici *et al*.,[18] Shah *et al*.,[19] and Gosavi *et al*.[24] in Indian population, Sangiampong *et al*.[23] in Thai population. However, the high incidence of Type 2 followed by Type 3 and very low incidence of type 1 scapulae were observed by Coskun *et al*. in Turkish population.[12]

The present study reveals that there is no significant difference in the parameters between the right and left scapulae. Hence, in case of osteological reconstruction, either scapula can be used, but limited within race as acromion process of scapula shows racial variation. This will be useful in personal identification for any medicolegal investigator in identifying unknown human remains of medicolegal cases.

CONCLUSION

The acromion process offers stability to the shoulder joint. The results of the present study regarding the morphometric data of acromion process highlight the importance in treating shoulder joint pathologies such as rotator cuff disease, shoulder impingement syndrome, and also during the interventions of shoulder joint disorders. This study may also be important in racial determination and forensic investigations, thus helpful for anthropologists, forensic experts, and surgeons.

Population group	Author	Type of acromion process
Orissa	present study	Curved>flat>Hooked
Egyptian	El-Din *et al*.	Curved>Flat>Hooked
Indian	Saha *et al.*	Curved>Flat>Hooked
Maharashtra	Gosavi *et al*.	Curved>Flat>Hooked
Turkish	Coskum *et al.*	Curved>Hooked>Flat
Brazilian	Schetino *et al*.	Curved>Hooked>Flat
Thai	Sangiamong *et al*.	Curved > Hooked = Flat

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