MORPHOMETRY OF THE ACROMION PROCESS OF HUMAN SCAPULAE AND ITS CLINICAL IMPLICATIONS

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ABSTRACT

BACKGROUND

Morphometry of the acromion process of scapula is an important diagnostic tool for various ailments in the shoulder joint. It is implicated in impingement syndrome and the pathogenesis of rotator cuff diseases.

Aims and Objectives- To record the morphometric values of the acromion process of scapula, establish the relationship between various parameters and to compare the values obtained with that of other studies in different populations.

MATERIALS AND METHODS

The study was carried out on 40 dry scapulae of unknown age and sex. The acromial length, acromial breadth, acromio-coracoid distance, acromio-glenoid distance and the length of the scapula were measured with the help of sliding vernier calliper and measuring tape. Different types of the acromion process were also noted.

RESULTS

The mean length of the acromion process on the right and left scapulae were 4.22 cm and 4.24 cm respectively. The mean breadth of the acromion process on the right and left scapulae were 2.65 cm and 2.64 cm respectively and the mean length of the right and left scapulae were 13.88 cm and 14.22 cm respectively. The mean acromio-coracoid distance on the right and left scapulae were 3.97 cm and 4.14 cm respectively. The mean acromio-glenoid distance on the right and left scapulae were 3.13 cm and 3.25 cm respectively. Type II (curved) acromion was observed in majority (72.5%), type I (flat) in 22.5% and type III (hooked) in 5%.

CONCLUSION

The results of the present study may be of help to clinicians to understand and treat various shoulder joint disorders.

KEYWORDS

Acromion, Scapula, Impingement, Rotator Cuff Diseases.

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BACKGROUND

Scapula also known as the shoulder blade is a large triangular, flat bone which is situated in the posterolateral aspect of the chest wall overlapping the second to seventh ribs. It presents two surfaces- costal and dorsal; three borders- superior, lateral and medial; three angles- inferior, superior and lateral; and three processes- the spine, the acromion and the coracoid. The acromion process projects forward at right angle as a flattened plate from the lateral end of the spine of the scapula. The acromion presents lateral and medial borders, tip, dorsal and undersurface. The lower border of the crest of the spine becomes continuous with the lateral border of the acromion at the acromial angle. This is a subcutaneous bony landmark. The medial border of the acromion is short and has a small oval facet directed upwards and medially for articulation with the lateral end of the clavicle to form a plane synovial acromioclavicular joint. The tip of acromion gives attachment to the coracoacromial ligament, the medial end of which is attached to the posterolateral margin of the coracoid process. Thus the undersurface of anterior third of the acromion process, the coracoacromial ligament and the coracoid process form together the coracoacromial arch, which provides a hood-like protection for the shoulder joint.[1] This coracoacromial arch would prevent upward dislocation if abnormal upward force is exerted on the humerus. The subacromial space is underneath this arch. The rotator cuff tendons, subacromial bursa, the biceps tendon and proximal humerus pass beneath this arch in the subacromial space. The height of this space under normal circumstances is about 1.5 cm between the bony components of the articulation. The rotator cuff is formed by fusion of the tendons of the subscapularis anteriorly, supraspinatus superiorly and infraspinatus and teres minor posteriorly.[2] Any abnormality that disturbs the relationship of these subacromial structures may lead to impingement. The predominant theory for the impingement syndrome classifies the contributing factors as anatomical and functional.

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The anatomical factors that may excessively narrow the subacromial space include variations in shape and inclination of the acromion or prominent osseous changes in the inferior aspect of coracoacromial arch.[3] The impingement may also occur as a result of thickening of the rotator cuff from acute or chronic inflammation. The present study analyses the morphometry of the acromion process of scapula, which may help orthopaedicians during surgical repair around the shoulder joint. It may also be helpful to anthropologists during their study on evolution of acromion.

MATERIALS AND METHODS

The present study was carried out on 40 dry adult human scapulae (21 right and 19 left) of unknown age and sex in the Department of Anatomy, Rajah Muthiah Medical College, Chidambaram. The type of the acromion process was identified and also the following parameters of acromion process were measured with the help of a vernier calliper and a measuring tape-

1. The maximum length of the acromion process was measured as the antero-posterior distance along the long axis.
2. The maximum breadth of the acromion process was measured as the maximum distance between the lateral and the medial borders at the midpoint of the acromion process.
3. The acromio-coracoid distance was measured between the tip of the acromion process and the tip of the coracoid process.
4. The acromio-glenoid distance was measured as the distance between the tip of the acromion process and supraglenoid tubercle.
5. The length of the scapula was noted as the maximum distance between the superior and inferior angle.

The above data was then statistically analysed using SPSS software. Descriptive statistics like percentage, mean and standard deviation were used to analyse the data obtained. Using Pearson correlation coefficient values, the relationship between various variables have been tabulated.

RESULTS

In the present study, the length of the acromion process of right scapulae varies from 2.5 cm to 6.2 cm with an average of 4.22 cm and that of the left scapulae varies from 3.1 cm to 4.9 cm with an average of 4.24 cm (Table 1). The breadth of the acromion process of right scapulae varies from 2.0 cm - 3.5 cm with an average of 2.65 cm and that of left scapulae varies from 1.5 cm - 3.5 cm with an average of 2.64 cm (Table 2). The acromio-coracoid distance ranges from 1.49 to 4.83 cm with an average of 3.97 cm on the right side and 3.0 to 5.0 cm with an average of 4.14 cm on the left side (Table 3). The acromio-glenoid distance varies from 2.54 to 3.84 cm with an average distance of 3.13 cm and from 2.70 to 3.80 cm with an average distance of 3.25 cm on right and left respectively (Table 4). The length of right scapula varies from 11 to 16 cm with an average of 13.88 cm and that of left scapula varies from 13 to 17 cm with an average of 14.22 cm (Table 5). Type II (curved) acromion process was observed in 72.5%, Type I (flat) in 22.5% and Type III (hooked) in 5%. The relationship between variables using Pearson correlation coefficient values was done. With increase in the length of the scapula, there is a corresponding increase in the length of acromion, acromio-coracoid and acromio-glenoid distance. There is a linear relationship between the acromio-coracoid and acromio-glenoid distance (Table 6).

Details of Measurement	Right (21)	Left (19)
Range	2.5 - 6.2 cm	3.1 - 4.9 cm
Mean	4.22 cm	4.24 cm
Standard deviation	1.068	0.772
Mean standard error	0.233	0.182

Table 1. Statistical Measurements of the Length of the Acromion Process (n= 40)

Details of Measurement	Right	Left
Range	2.0 - 3.5 cm	1.5 - 3.5 cm
Mean	2.65 cm	2.64 cm
Standard deviation	0.484	0.681
Mean standard error	0.105	0.160

Table 2. Statistical Measurements of the Breadth of the Acromion Process (n= 40)

Details of Measurement	Right	Left
Range	1.49 - 4.83 cm	3.0 - 5.0 cm
Mean	3.97 cm	4.14 cm
Standard deviation	0.801	0.682
Mean standard error	0.174	0.160

Table 3. Statistical Measurements of the Acromio-Coracoid Distance (n= 40)

Details of Measurement	Right	Left
Range	2.45 - 3.84 cm	2.70 - 3.80 cm
Mean	3.13 cm	3.25 cm
Standard deviation	0.529	0.653
Mean standard error	0.115	0.154

Table 4. Statistical Measurements of the Acromio-Glenoid Distance (n= 40)

Details of Measurement	Right	Left
Range	11.0 - 16.0 cm	13.0 - 17.0 cm
Mean	13.88 cm	14.22 cm
Standard deviation	1.348	1.360
Mean standard error	0.294	0.320

Table 5. Statistical Measurements of the Length of the Scapula (n= 40)

Population Group	Author	Type of Acromion Process
South Indian	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	Coskun et al	Curved> Hooked> Flat
Brazilian	Schetino et al	Curved> Hooked> Flat
Rajasthan	Singh et al	Curved= Hooked> Flat
Thai	Sangiampong et al	Curved> Hooked= Flat

Table 6. Comparison of Types of Acromion in Different Populations

Pearson Correlation Coefficient Variables	Length of Acromion	Acromio-Coracoid Distance	Acromio-Glenoid Distance	Length of Scapula
Length of acromion	---	-0.805	0.226	0.378*
Acromio-coracoid distance	-0.085	---	0.458**	0.378*
Acromio-glenoid distance	0.226	0.458**	---	0.329*
Length of scapula	0.378*	0.378*	0.329*	---

Table 7. Relationship between various Variables using Pearson Correlation Coefficient Values

*Correlation is significant at 0.05 level (2-tailed)
*Correlation is significant at 0.01 level (2-tailed)

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. Changes in posture provided the stimulus for the initiation of morphological changes. The shape of the scapula is dependent upon posture and functional requirements of the muscles attached to it. 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 the scapula and the acromion process during development from the pronograde to the orthograde. This change is due to the progessive 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 characteristics noted are the lateral orientation of the glenoid cavity, wide acromion that projects laterally above a horizontally oriented glenoid cavity and a narrow coraco-acromial arch. The slope of the acromion is steeper, which is resposible for narrower subacromial space. These features may explain in part the pathogenesis of impingement syndrome in humans.[5] In 1931, Codman reported that the degenerative changes of the tendons initiate rotator cuff tears.[6] Later on, Neer in 1983 stated that 95% of cuff tears are caused by mechanical impingement and reported successful treatment by anterior acromioplasty.[7] The indication for acromioplasty is based on clinical evaluation 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- I), curved (Type- II) or hooked (Type- III) acromion on outlet-view radiographs and found the prevalence as Type I (18.6%), Type II (42%) and Type III (38.6%). The rotator cuff tears were commonly associated with type III.[8] Bigliani LU et al explained that different acromial shapes is likely to develop due to both genetic and acquired causes. Age is the 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 I (26.1%), Type II (55.6%) and Type III (18.1%). The mean value of the acromion-coracoid distance was 2.81 cm. The mean value of the acromion-glenoid distance was 1.77 cm and the mean value of scapular length was 14.76 cm.[10] Singh J 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 I (22.5%), Type II (38.8%) and Type III (38.8%). Acromio-coracoid and acromio-glenoid distance were 3.75 cm and 2.7 cm respectively. They also found the mean value of scapular length as 14.46 cm (right) and 14.57 cm (left).[11] Similar study done by Coskun et al reported the acromian 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 et al found the mean value of acromion length and width as 4.24 cm and 2.65 cm respectively. The mean acromion-coracoid distance was 3.40 cm and acromio-glenoid distance was 3.01 cm, the prevalence of occurrence of acromion was Type I (37.1%), Type II (47.5%) and Type III (15.2%).[14] Mansur et al had reported that the mean length of acromion process of right scapula was 4.64 cm and that of left side was 4.55 cm. The mean width of acromion was 2.66 cm on right side and 2.72 cm on left side. They observed the mean values of acromio-coracoid distance on the right and left side as 3.90 cm and 3.93 cm respectively and the mean values of acromio-glenoid distance as 3.18 cm on right side and 3.19 cm on left side.[3] Nweke CI 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). Acromio-coracoid distance was 3.9 cm (right) and 4.0 cm (left). Acromio-glenoid distance was 3.01 cm and 3.03 cm on the right and left side respectively.[15]

Edelson JG et al in their study concluded that the length and slope of the acromion process was 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]

Ritu Singroha et al reported high incidence of Type II (curved) followed by Type III (hooked) and very low incidence of Type I (flat) scapulae.[17] Yazici et al in their study found Type I (22.5%), Type II (70%) and Type III (5%).[18] Shah et al concluded the frequency as Type I (17%) and Type II (83%).[19] Farley TE 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 K et al quoted that subacromial impingement syndrome and rotator cuff tears were common in Type III acromion due to 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 two 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 decrease the subacromial space leading to impingement.[23]

In the present study, the mean length of the acromion process was observed to be 4.22 cm and 4.24 cm on the right

and left scapulae which did not show much variation with other studies. Breadth of acromion was 2.65 cm on both sides. Other studies also reported similar values, except it was higher in the study of Sitha et al in Thais.[13] Acromio-coracoid distance and acromio-glenoid distance were almost similar to previous studies. But in the Turkish study done by Coskun et al,[12] the acromio-coracoid distance was 1.78 cm and in the Greek study done by Paraskevas G et al the acromio-glenoid 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 G et al[10] and Singh J et al.[11] In the present study Type I (flat) was seen in 22.5%, Type II (curved) in 72.5% and Type III (hooked) in 5%. Thus, high incidence of Type II followed by Type I and very low incidence of Type III scapulae were observed in the present study which is similar to the results obtained by Paraskevas et al,[10] Singh 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, El-Din et al[25] in Egyptian population and Musa et al in Turkish population.[26] But high incidence of Type II followed by Type III and very low incidence of Type I scapulae were observed by Coskun et al in Turkish population[12] and Schetino et al in Brazilian population[27] (Table 7). Hirano M et al noted higher frequency of occurrence of Type III and Type I. They also reported that Type III acromion was the most common in patients with rotator cuff tears and the tear size was significantly larger.[28]

The present study reveals that there is no significant difference in the parameters between the right and left scapulae. So 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 medico-legal 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 diseases, 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.

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