Original Article

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Morphometric Study of Acromion Process of Scapulae

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Abstract:

Background: The scapula is a triangular bone essential for shoulder movement, with the acromion forming the highest point and articulating with the clavicle at the acromioclavicular joint. Variations in the shape and size of the acromion process are clinically significant, as they are linked to conditions such as impingement syndrome, rotator cuff tears, and degenerative changes.

Objective: To analyze the morphometric variations of the acromion process of the scapulae.

Methods: This cross-sectional analytical study was conducted in the Department of Anatomy, Sylhet MAG Osmani Medical College, Sylhet, from 1 July 2021 to 30 June 2022. A total of 200 dried, grossly normal scapulae were examined, of which 104 were male and 96 were female, determined using the discriminant function analysis technique and subsequently grouped by sex. A purposive sampling technique was followed. Data were collected in a pre-designed data collection sheet, and measurements were taken with a digital vernier caliper.

Results: The morphometric analysis of the acromion process revealed that the length and breadth were generally greater in males than in females for both sides. For the right acromion, males had a length ranging from 31 mm to 48.62 mm (mean 39.96 ± 4.85 mm) and females from 30.70 mm to 47.62 mm (mean 37.53 ± 5.70 mm), with a significant difference ($p < 0.013$). On the left side, males showed a length of 31.50 mm to 52.15 mm (mean 42.06 ± 5.41 mm) and females 30.50 mm to 51.17 mm (mean 40.51 ± 5.70 mm), also significantly higher in males ($p < 0.016$). Overall, the left acromion length was significantly greater than the right ($p < 0.05$). Regarding breadth, the right acromion in males ranged from 17.76 mm to 35.19 mm (mean 23.42 ± 2.98 mm) and in females 16.34 mm to 34.80 mm (mean 21.62 ± 3.09 mm), with a significant male–female difference ($p < 0.014$). For the left acromion, male breadth ranged from 18.12 mm to 37.98 mm (mean 35.19 ± 4.85 mm) and female from 16.29 mm to 35.98 mm (mean 22.54 ± 3.38 mm), with a highly significant difference ($p < 0.001$). Although the left acromion breadth was higher than the right in both sexes, this difference was not statistically significant ($p > 0.05$).

Conclusion: The study demonstrates that males generally exhibit greater length and breadth of the acromion process compared to females. The study demonstrates that males generally exhibit greater acromion length and breadth compared to females. The left acromion is typically larger than the right in both sexes, showing a significant difference in length, though not in breadth. These results offer valuable baseline morphometric data that can support clinical evaluations, orthopedic interventions, and forensic investigations.

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Introduction:

Morphometrics (from Greek Morphe, ''Shape, form'', and Metria, ''measurement'') or morphometry refers to the quantitative analysis of form, a concept that encompasses size and shape.

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The scapula is a flat, triangular bone that lies over the posterolateral chest wall, extending from the second to the seventh ribs. Along with the clavicle it forms an important component of the shoulder girdle which connects the appendicular skeleton to the axial skeleton.

Sexual dimorphism plays a key role in forensic anthropology. Humphrey stated that after growth is completed, the scapula exhibits sexual dimorphism. Dimorphism in scapula is reflected in its length, breadth, glenoid fossa, coracoid and acromion processes.[1]

The acromion (from Greek *akros* meaning "highest" and *omos* meaning "shoulder") is a bony projection of the scapula that continues from the spinous process. It develops from several ossification centers— pre-acromion, meso-acromion, and meta-acromion —which gradually fuse to form a triangular epiphyseal bone that eventually joins with the basi-acromion. The basi acromion typically fuses with the scapular spine by around 12 years of age, and all four centers are usually fused between 15 and 18 years.[2] In 1% to 15% of individuals, this fusion does not occur, resulting in a separate accessory bone known as the os acromiale.[2,3]

The coracoacromial arch is formed by the acromion and coracoid processes, connected by the coracoacromial ligament. This arch extends laterally over the shoulder joint and, together with the clavicle, forms the acromioclavicular joint. The subacromial space is located beneath the arch, bordered inferiorly by the humeral head and superiorly by the anterior third of the acromion, the coracoacromial ligament, and the acromioclavicular joint. Radiographically, the distance between the acromion and humeral head typically measures 1.0 to 1.5 cm.[3,4,5] This space houses the rotator cuff tendons, the tendon of the long head of the biceps brachii, and a bursa. Narrowing of the subacromial space can result in shoulder impingement syndrome, often due to structural abnormalities of the coracoacromial arch.[2] Variations in acromion morphology significantly influence the dimensions of this space. Bigliani LU et al. classified the acromion into three types based on its concavity: type I (flat), type II (curved), and type III (hooked).[2,6,7] The initial thickness of the acromion process assists orthopedic surgeons in determining the amount of bone to be removed while preserving sufficient structure to maintain rotator cuff function after surgery.[4,8,9] Variations in acromion morphology are recognized as contributing factors to impingement syndrome and rotator cuff injuries.[5,6] Since acromioplasty remains the standard surgical intervention for shoulder impingement,[7,9,10] a thorough understanding of the acromion's morphology and morphometry is crucial for effective treatment. Furthermore, bone dimensions and shapes can differ within and between populations. Several studies have described the morphology and morphometry of the acromion process in different populations.[7,11] Therefore, this study aimed to analyze the morphometric variations of the acromion process of the scapula.

Materials and methods

This cross-sectional analytical study was conducted in the Department of Anatomy, Sylhet MAG Osmani Medical College, Sylhet**,** from 1 July 2021 to 30 June 2022. The study was performed on dry, ossified scapulae collected from the Department of Anatomy, fulfilling the inclusion criteria. A total of 200 samples were included. Dried, grossly normal right and left scapulae were included, while fragmented or distorted bones and specimens showing evidence of previous trauma or skeletal disorders were excluded.

Dry ossified scapula of unknown sex collected. The sex of the dry scapulae was initially unknown, and was subsequently determined using the discriminant function analysis technique.[12] The technique was applied to the collected data and discriminant functions were generated by discriminant function analysis technique, the sex was determined and the grouping was done.

Constant + Co-efficient x Variable
$Z = bo + b1\ X\ x1$
Here Z = Discriminant function b0 = constant
b1 = co-efficient
X1 = variable

A sectioning point was created by using the mean discriminant scores. To assign the case to either male or female sex, the product Z was

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compared to theconstant and the co-efficient for each variable was calculated to the sectioning point derived by the discriminant function analysis. A value higher than the sectioning point indicated a male scapula, whereas a value lower than the sectioning point indicated a female scapula. Value of the constant and the coefficient for each variable was calculated by using SPSS version 23.0. If Z is more than cut point the bone is classified as male. If Z is less than cut point the bone is classified as female.

Among the 200 dry ossified scapulae**,** 104 were classified as male and 96 as female. Which was used for academic purpose, collected from Department of Anatomy, Sylhet MAG Osmani Medical College, Sylhet. Different morphometric parameters of the acromion process were measured using standard procedures. After completion of data collection, all forms were checked for accuracy and completeness**.** Finally, data were processed and analysed by a software programme on SPSS (Statistical Package for Social Sciences) for Windows (Version 23.0). After entry into computer, results were analysed according to objectives and variables of the study. Statistical test 'unpaired t-test, and paired t-test was done. Data were expressed as mean ± SD. Statistical significance was accepted at p- value equal to or less than 0.05 ($p \leq 0.05$). Results were presented in tabular form.

Fig 1: Illustration of the length of the acromion process

Fig:2 Illustration of the breadth of the acromion process

Results

In males, the right acromion length ranged from 31.00 mm to 48.62 mm, with a mean of 39.96 ± 4.85 mm. In females, the right acromion length ranged from 30.70 mm to 47.62 mm, with a mean of 37.53 ± 5.70 mm. In male, the left acromion length ranged from 31.50 mm to 52.15 mm and the mean length of acromion was 42.06±5.41 mm. In female, the length of acromion ranged from 30.50 mm to 51.17 mm and the mean length was 40.51 ± 5.70 mm (Table 1). In male, the breadth of acromion ranged from 17.76 mm to 35.19 mm and the mean length was 23.42 ± 2.98 mm. In female, the breadth of acromion ranged from 16.34 mm to 34.80 mm and the mean length was 21.62 ± 3.09 mm. In male, the breadth of acromion ranged from 18.12 mm to 37.98 mm and the mean length of acromion was 35.19 ± 4.85 mm. In females, the left acromion breadth ranged from 16.29 mm to 35.98 mm**,** with a mean of 22.54 ± 3.38 mm **(**Table 2**)**.

Table 1: Measurement of the length of acromion for left and right side (N = 200)

Variables	Male (n = 104)		Female (n = 96)		P value
	Mean±SD	Range	Mean±SD	Range	
Length of Right acromion (mm)	39.96±4.85	31-48.62	37.53±5.29	30.70-47.62	0.013
Length of Left acromion (mm)	42.06±5.41	31.50-52.15	40.51±5.70	30.50-51.17	0.016
P value	0.011		0.019		

P value calculated by unpaired 't' test between male and female, paired 't' test between right and left, SD = Standard deviation. n = sample

Table 2 : Measurement of the breadth of acromion for left and right side (N=200)

Variables	Male (n=104)		Female (n=96)		P value
	Mean±SD	Range	Mean±SD	Range	
Breadth of Right acromion (mm)	23.42±2.98	17.76 35.19	21.62±3.09	16.34 34.80	0.014
Breadth of Left acromion (mm	25.80±3.45	18.12 37.98	22.54±3.38	16.29 35.98	0.001
P value	0.247*		0.243*		

P value calculated by unpaired 't' test between male and female, paired 't' test between right and left, SD = Standard deviation. n = sample

Discussion

It is widely known that factors such as region, race, gender, and age influence scapular morphometry**.** Therefore, the identification of each population needs to adhere to its own unique norms in order to be as accurate as possible. Variations in bone morphology are clinically significant. Few, but significant anatomical changes of the scapula are essential for comprehending various shoulder pathologies, treating various disorders of the shoulder joint, and developing shoulder implants. Including direct measurements of dry bones, measurement from fresh cadavers, radiographic evaluation of cadaveric scapulae, and radiological assessments in living individuals from cadavers, and radiographic measurement in living patients from various populations.[13]

The present study was conducted on 200 dry ossified scapulae (100 right and 100 left) to measure several scapula parameters. In the present study, all variables were measured using a vernier caliper to determine the various parameters of the scapula. The study's data were statistically analyzed and significant information on the parameters of the scapulae was discovered. There were some similarities and differences between the variables of this study and the data presented in various publications. Similarities may have resulted from the selection of study populations from the same subcontinental region. The dissimilarities may be attributable to mixture of different races, different geographical distribution or scapula taken from cadavers, and the application of different measurement techniques. The findings of the present study were compared to those of other studies in which researchers conducted their research with individuals from many nations, including India, Nigeria, Myanmar, China, and Egypt. The variables were analyzed individually and compared to the findings of other studies.

Discussion of the length of acromion

In the present study, the right and left acromion mean length of acromion was significantly higher ($p<0.004$) in male than female. Manikum et al.[14] reported that mean length of acromion process was significantly ($p<0.000$) higher in male than female. Singroha et al. (2017) observed a significantly longer acromion process in males, reporting a mean length of 47.7 ± 5.85 mm in males and 40.5 ± 3.36 mm in females, values slightly higher than those in the present study.

In this study, the left acromion length was significantly greater than the right in both sexes ($p < 0.05$). One study reported a mean acromion length of 41.007 ± 6.64 mm, with a range of 21.58– 59.72 mm, values comparable to the present findings. Jacinth et al.[1] similarly reported mean lengths of 42.2 mm (right) and 42.4 mm (left).

Discussion of the breadth of acromion

In the present study, the mean breadth of the acromion was significantly greater in males than females ($p < 0.000$) for both sides. This aligns with findings from Manikum et al. (2015) and Singroha et al.[15], who reported mean acromion breadths of 26.8 ± 2.58 mm in males and 23.2 ±

2.32 mm in females, values comparable to the present study.

The current study also showed that the left acromion breadth was greater than the right, although the difference was not statistically significant ($p > 0.05$). Other studies have also reported similar results. One study found a mean acromion breadth of 22.3 mm, ranging from 19 to 28 mm**.** Jacinth et al.[1] and Priya et al.[17] reported slightly higher values, with mean acromion breadths ranging between 24.3–26.5 mm (right) and 24.2–26.4 mm (left).

Conclusion:

The study demonstrates that both the length and breadth of the acromion process are significantly greater in males compared to females. Additionally, the left acromion tends to be larger than the right in both sexes, with a statistically significant difference in length but not in breadth. These findings provide valuable baseline morphometric data that may assist in clinical evaluation, orthopedic surgical planning, prosthetic design, and forensic identification**.**

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