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Anthropometric Study of Different Angles of Left Human Scapula in Adult Bangladeshi People

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ABSTRACT

Introduction: The scapula, or shoulder blade, is a triangular bone that connects the upper limb to the trunk, articulating with the humerus at the glenoid cavity. It features three borders (superior, medial, and lateral), three angles (superior, inferior, and lateral), and significant anatomical landmarks such as the scapular spine, acromion, and coracoid processes.

Aim/Objectives: This study aimed to examine the morphometry of dry, fully ossified left human scapulae and identify variations between male and female scapulae.

Methods: This cross-sectional study, conducted at Dhaka Medical College from July 2022 to June 2023, analyzed 140 dry, fully ossified left human scapulae of unknown sex. Sex determination was performed using Dabbs's multivariate linear discriminant function method. Scapulae were classified into male and female groups based on measurements of various morphometric and morphological variables, including length, width, scapular angles, and glenoid cavity features.

Result: To assess morphometric parameters and anatomical variations, the study examined 140 ossified left human scapulae (66 male, 74 female). In male, the mean ± SD of superior angle was 89.22 ± 4.94 mm and it ranged from 78.16mm to 98.16 mm. In female, the mean ± SD of superior angle was 85.49 ± 9.52 mm and it ranged from 45.00 mm to 96.66 mm. The mean superior angle was found to be higher in male than female and these differences were statistically significant ($p<0.01$). In male, the mean ± SD of inferior angle was 51.57 ± 6.13 mm and it ranged from 41.66 mm to 68.66 mm. In female, the mean ± SD of inferior angle was 48.75 ± 5.80 mm and it ranged from 36.66 mm to 75.12 mm. The mean inferior angle was found to be higher in male than female and these differences were statistically significant ($p<0.01$). As $p<0.05$, null hypothesis (no difference in measurement of superior angle and inferior angle of scapula between male and female) was rejected and alternate hypothesis (there are differences in measurement of superior angle and inferior angle between male and female) was accepted. So, result was significant.

Conclusion: This study concludes that significant sexual dimorphism exists in the scapular morphology of adult Bangladeshi individuals. Males generally have larger scapular dimensions than females, and there are notable sex-based differences in anatomical variations, such as suprascapular notch types and acromion angles.

Key Words: Scapula Morphometry, Sexual Dimorphism, Anatomical Variations, Human Scapula Anatomy, Suprascapular Notch Types, Acromion Angles

INTRODUCTION

The scapula, also known as the shoulder blade, is a triangular bone located laterally on the upper quadrant of the skeleton. The bone attaches to the humerus at the glenoid cavity, providing an important attachment of the shoulder girdle to the trunk. The scapula is a part of the axial skeleton structure known as the shoulder girdle; sometimes, it is referred to as the pectoral Girdle or the upper limb girdle.[1] The scapula is dorsally located overlying the 2nd to seventh ribs[1]. This border is superior, extending from the base of the coracoid process to the superior angle. The medial border is the longest, extending from the superior to the inferior angle. The lateral border is the thickest and is usually concave, extending from the inferior angle superiorly terminating at the head or neck of the scapula at the infraglenoid tubercle. The scapula has three angles: superior, inferior, and lateral. The superior angle is at the intersection of the medial and superior border.[1] The

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root of the scapular spine is referred to as the spinous axis. The spine extends dorsally and laterally from the spinous axis, terminating at the acromion process. The acromion process is where the scapula articulates with the clavicle. Hooking superiorly and anteriorly from the scapular neck is the coracoid process. The scapular neck is located directly behind the glenoid cavity. The glenoid cavity (or fossa) is a flat plate of bone located where the scapula laterally articulates with the head of the humerus. Below the glenoid cavity is often a glenoid sub-fossa (infraglenoid tubercle).[2] The most common position of the nutrient foramen is the supraspinous fossa, which is located inferior to the suprascapular notch. The variation of supra-scapular notch morphology has been analyzed, and a correlation has been found between notch type and injury frequency. Ossification of the suprascapular ligament results in converting the suprascapular notch into the foramen, through which the suprascapular nerve passes. Comprehension of the morphometry of the coracoid process was imminent ahead of the latarjet procedure for glenohumeral instability with significant bone loss where the coracoid process of the scapula can be used as a bone graft and transferred to the glenoid defect. The acceptable length and width of the coracoid process were taken as a prerequisite for proper positioning of screws during surgery, thereby preventing the failure of the operation. It is necessary to know the role of coracoid morphometry in causing the subcoracoid impingement syndrome. The structure of acromion is a causative factor in impingement syndrome of the shoulder joint, so understanding its morphometry becomes important. The variations of the acromion process should also be in the surgeon's mind, especially regarding the shoulder joint for impingement and rotator cuff injuries. The glenoid cavity is small and allows only a restricted area for limited fixation devices. Several conditions can cause shoulder pain and disability and lead patients to consider shoulder joint replacement surgery.[3] They are osteoarthritis, rheumatoid arthritis, post-traumatic arthritis, rotator cuff tear arthropathy, avascular necrosis (osteonecrosis), and severe fractures. In shoulder replacement surgery, the damaged parts of the shoulder joint are removed and replaced with artificial components called prostheses. The treatment options are replacing just the head of the humerus bone (ball), known as hemiarthroplasty, or replacing the ball and the socket (glenoid), known as total shoulder arthroplasty.[4] For this reason, knowledge of the morphology of the glenoid cavity is important in designing and fitting glenoid components for total shoulder arthroplasty. Studies of the scapula have shown that this bone tends to a number of valuable studies, including evolution, age estimation, and sex determination. A comprehensive overview of scapula development and morphology and extensive analysis of scapula research are also demonstrated. This study aimed to examine the morphometry of dry, fully ossified left human scapulae and identify variations between male and female scapulae.

METHODOLOGY & MATERIALS

This cross-sectional analytical study was conducted in the Department of Anatomy, Dhaka Medical College, Dhaka, over one year, from July 2022 to June 2023. A total of 140 dry, fully ossified left human scapulae of unknown sex were collected. Sex determination was performed using Dabbs's multivariate linear discriminant function analysis method.[2] The discriminant function technique was applied to the collected data to generate a discriminant function, which was then used to determine sex and classify the scapulae into male and female groups. Ethical clearance was obtained from the Research Review Committee (RRC) and the Ethical Review Committee (ERC) of Dhaka Medical College, Dhaka, before conducting the study.

Inclusion Criteria:

- Dry Fully ossified left human scapula

Exclusion Criteria:

- Broken or part of scapula is missing
- Fracture of the scapula
- Any degenerative changes of the scapula

Sample selection and evaluation criteria: The ossification of the scapula is completed by the age of the twentieth year[3]. So, a fully ossified scapula is achieved in adult form after this age. International Congress of Prehistoric Anthropometry and Archeology, Geneva, agrees that paired bilateral structures with left-sided measurements are recommended.[4] Most people are right-handed, so the gross activity of the right side produces structural changes in the right scapula. A fully ossified dry left human scapula was considered a sample for this study.

Equipment used for measuring variables: The following equipment was used to measure the variables in this study: a digital vernier caliper for precise dimensional measurements, a digital camera to capture visual records, a protractor for angle measurements, and a scale for linear measurements.

Variables of study: The study focused on various morphometric and morphological variables of the left scapula to provide a comprehensive anatomical assessment. The measured parameters included the maximum length and width of the scapula, the maximum length of the scapular spine, the length of the superior border, and the angles at the superior and inferior scapular edges. Additionally, the lengths of the supraspinous and infraspinous lines, the height and breadth of the glenoid cavity, and the lengths of the coracoid and acromion processes, along with the breadth of the acromion process, were recorded. Distances such as the coracoglenoid distance and acromion-coracoid distance were also evaluated. Morphological features such as the superior transverse diameter of the suprascapular notch, types of the suprascapular notch, number and position of nutrient foramina, types of superior border, types of the acromion process, the shape of the subacromial space, types of acromion angle, types of the scapular spine, and shapes of the glenoid cavity were documented. Finally, the scapular and glenoid cavity indexes were calculated further to characterize the scapula's proportions and anatomical variations.

Data processing and analysis: The data collected from morphological studies were processed to get mean values, standard deviation, and percentage values as applicable. The statistical analysis was performed with the help of the Department of Statistics, Dhaka University, with the help of SPSS released for Windows version 25.0. The unpaired student ¨t¨ test was done for comparison between males and females. Statistical analysis was accepted at a p-value equivalent to or less than 0.05.

RESULTS

The study analyzed 140 dry, fully ossified left human scapulae (66 male, 74 female) to evaluate various morphometric parameters and anatomical variations. In male, the mean ± SD of superior angle was 89.22 ± 4.94 mm and it ranged from 78.16mm to 98.16 mm. In female, the mean ± SD of superior angle was 85.49 ± 9.52 mm and it ranged from 45.00 mm to 96.66 mm. The mean superior angle was found to be higher in male than female and these differences were statistically significant ($p<0.01$). In male, the mean ± SD of inferior angle was 51.57 ± 6.13 mm and it ranged from 41.66 mm to 68.66 mm. In female, the mean ± SD of inferior angle was 48.75 ± 5.80 mm and it ranged from 36.66 mm to 75.12 mm. The mean inferior angle was found to be higher in male than female and these differences were statistically significant ($p<0.01$). As $p<0.05$, null hypothesis (no difference in measurement of superior angle and inferior angle of scapula between male and female) was rejected and alternate hypothesis (there are differences in measurement of superior angle and inferior angle between male and female) was accepted. Therefore, result was significant.

Table 1: Measurement of superior and inferior angle of left scapula in male and Female (N =140)

Variable	Male (n=66)	Female (n=74)	p-value
Measurement of superior angle (mm)			
Mean ± SD	89.22±4.94	85.49±9.52	0.005**
Range (min-max)	(78.16-98.16)	(45.00-96.66)	
Measurement of inferior angle (mm)			
Mean ± SD	51.57±6.13	48.75±5.80	0.006**
Range (min-max)	(41.66-68.66)	(36.66-75.12)	

DISCUSSION

The morphological variation reflects size and shape differences in the human skeleton. Sex determination constitutes the most important element during the identification process of human skeleton remains. The scapula is one of the bones that manifest sexually dimorphic features. Sexual dimorphism is the development of visible morphological differences between males and females in a species or population.[5,6] According to Plavcan sexual dimorphism in the skeleton of primates is related to overall body size differences.[7] Therefore, the human skeleton displays sexually dimorphic characteristics expressed by larger and more robust male bones. There are many factors affecting differences between the two sexes. They include environmental conditions (diet, mechanical stress, and physical activity patterns) and genetic background. However, the most important is believed to be genetic composition. Genetic factors are known to play an important role in the size of individual bones, but they are related predominantly to dimensions responsible for their growth. This may explain why the maximum length of the scapula was the most dimorphic. Another very important factor affecting the expression of sexual dimorphism is the environment, especially diet. Long-term protein deficiency reduces the growth rate of the skeleton, and it does so to a greater degree in males than females. In the present study, the mean maximum length of superior border of left scapula was significantly higher in male than female ($p<0.05$).Same findings was considered for the American population at $p\leq0.05$ level.[1] The same sexual difference was considered in the mixed Indian population (Gara, 2019) and the American population at $p<0.001$ and $p\leq0.01$ levels, respectively.[8] In the present study, the mean superior angle of left scapula was significantly higher in male than female ($p<0.01$).This analysis was dissimilar compared to the findings of Sharma et al.[9] In the present study, the mean inferior angle of left scapula was significantly higher in male than female ($p<0.01$). This analysis was dissimilar compared to the findings of Sharma et al[9]. However, the American population showed similar sexual differences but at different significance levels ($p\leq0.01$ and $p\leq0.05$, respectively).[1] Therefore, males cannot reach their maximum potential for stature, and sexual dimorphism is reduced. Once optimal conditions have been restored, males grow faster than females, increasing sexual dimorphism. Another environmental factor believed to contribute to changes between the two sexes is mechanical load, which depends on the division of labor according to sex. Greater mechanical loading sustained by males is responsible for their more robust skeleton. The degree of sexual dimorphism differs geographically and in temporally isolated populations. This is caused by secular changes that are the result of lifestyle modifications. A human race is defined as a group of people with certain common inherited features that distinguish them from another group of people. Blumenfeld J et al.[10] recognized four human racial subspecies: Homo sapiens europaeus (Caucasoid), Homo sapiens status (Mongoloid), Homo sapiens Africa (Negroid), and homo sapiens Americans (Australoid). Bangladesh has many ethnic groups with diverse genes and cultural traits. It has been said that South Asia is a land of two populations. The lighter-skinned Aryans are Caucasoid in origin, and the darker-skinned Dravidians are Australoids in origin. Dravidians were the original inhabitants of this region, whom the invading Aryans conquered and dominated. Thus, all major human races of the world had arrived in Bengal, and an Australoids dominant hybrid race is known as ˈBengaliˈ. Measurements taken on most of the bones in the body have shown higher mean values for males than females. The scapula follows a similar pattern. The present study's findings were statistically analyzed, revealing important information about morphometric variation in males and females. The results of this study were compared with other studies of different countries like India, Thailand, China, Poland, and America obtained from different publications. Different variables in the present study showed similarities and dissimilarities with findings from other studies on different racial groups in different countries. Admixture of different races, different geographical distribution, different climates, different cultures, different dietary habits, use of different measurement techniques, and also different sample sizes, as well as different age groups of study samples, causes variation in study findings among the population. In the present study, the mean maximum width of the left scapula was significantly higher in males than females ($p<0.01$). The same findings were considered for the Western Indian population and mixed Indian population at $p<0.001$ level.[11, 12] Dabbs and Moore Jansen[13] also showed similar sexual differences at the same significance level ($p\leq0.01$).

LIMITATIONS OF THE STUDY

The skeleton available in Bangladesh may come from neighboring countries. It can't be ensured that these collected skeletons belonged to the scapula of Bangladeshi people only. The study was based on physical measurement procedure which might have produced minor error of measurement. Articles published abroad did not contain all the studied variables of both sexes for which comparison was not possible in all cases.

CONCLUSION AND RECOMMENDATIONS

This study examined 140 left human scapulae from adult Bangladeshi individuals to explore sex-based differences in scapular morphology. Males consistently showed larger dimensions than females, including scapular length, width, spine length, glenoid cavity size, and process lengths, highlighting clear sexual dimorphism. These findings align with global patterns but reveal population-specific traits influenced by genetic, environmental, and lifestyle factors. This data provides valuable insight for forensic identification, anthropological research, and clinical applications in Bangladesh.

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