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Radiographic Analysis of the Angles of the Left Scapula in a Bangladeshi Population

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Abstract

The movements of the shoulder joint are influenced by the angles of the scapula. Among all the angles of the scapula, the gleno-polar angle measures the obliquity of the glenoid articular surface in relation to the scapular body, which is important for deciding the treatment and prognosis of floating shoulder. Therefore, a detail knowledge of scapular angles helps us to understand and treat the different shoulder disorders. We proposed this study to observe the angles of the left scapula in a Bangladeshi population through radiographic analysis. This cross-sectional, analytical study was conducted among 100 adult Bangladeshi people (50 male and 50 female) in the Department of Anatomy, Dhaka Medical College, Bangladesh, from July 2017 to June 2018. Radiographs of anterior-posterior view of the left shoulder was taken in the Department of Radiology & Imaging of the same institution. The procedure was done by using measurement toolbox of DICOM (Digital Imaging & Communications in Medicine) software with angle option. The superior, inferior, lateral and gleno-polar angles were found greater in male comparing to its female counterpart. There is no previous radiological study done on the angles of the scapula in Bangladesh by using such radiological software. This method is a non-invasive one. Measurement of angles of scapula by radiographic analysis provides accurate information about the pathomechanics of shoulder joint movement.

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Introduction

The scapula is a thick, flat bone lying on the thoracic wall that provides an attachment for three groups of muscles: intrinsic, extrinsic, and stabilizing and rotating muscles.[1] The intrinsic muscles of the scapula include the muscles of the ‘rotator cuff’ – the subscapularis, teres minor, supraspinatus, and infraspinatus. These muscles attach to the surface of the scapula and are responsible for the internal and external rotation of the shoulder joint, along with humeral abduction.[1,2] The extrinsic muscles include the biceps, triceps, and deltoid muscles and attach to the coracoid process and supraglenoid tubercle of the scapula, infraglenoid tubercle of the scapula, and spine of the scapula. These muscles are responsible for several actions of the glenohumeral joint.[1,3] The third group, which is mainly responsible for stabilization and rotation of the scapula, consists of the trapezius, serratus anterior, levator scapulae, and rhomboid muscles. These attach to the medial, superior, and inferior borders of the scapula.[1,2] The relationship between the bony anatomy and stability of a joint is important in the understanding of its biomechanical behaviour during movement. This is particularly important in the shoulder joint where there is discrepancy between the shape of the glenoid fossa and the humeral head.[3] The bipedal gait and consequential freedom of the upper limb in human beings has made the movements of the shoulder joint a subject of extensive investigations.[3,4]

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The role of the scapula has been studied from different viewpoints and its shape, size and movements have been correlated with the movements of the shoulder joint and the shoulder girdle.[3,4] The role of the scapula has been studied from different viewpoints and its shape, size and movements have been correlated with the movements of the shoulder joint and the shoulder girdle.[3] The scapula bears various angles namely superior, inferior, lateral and gleno-polar angle.[3,4] The superior angle of the scapula or medial angle, is covered by the trapezius muscle. This angle is formed by the junction of the superior and medial borders of the scapula.[1,2] The inferior angle of the scapula is the lowest part of the scapula and is covered by the latissimus dorsi muscle. It moves forwards round the chest when the arm is abducted. The inferior angle is formed by the union of the medial and lateral borders of the scapula.[1,2] The lateral angle of the scapula or glenoid angle also known as the head of the scapula is the thickest part of the scapula.[1,2] A gleno-polar angle ranging from 30° to 45° is considered normal. The gleno-polar angle is mainly used within the field of scapular surgery (for example, due to a scapular neck fracture).[4] The gleno-polar angle assesses the alignment of the glenoid and may provide prognostic information and aid the management of scapula fractures. The scapular angles provide the point of attachment and control to various muscles and have been associated with the different movements of the shoulder girdle and joint.[3] The movements of the shoulder joint are influenced by the angles of the scapula which provide the adequate leverage for the shoulder muscles.[1-4] Therefore, we proposed this study to observe the angles of the left scapula in a Bangladeshi population through radiographic analysis.

Methods

This cross-sectional, analytical study was conducted in the Department of Anatomy, Dhaka Medical College, Bangladesh, from July 2017 to June 2018. A total of 100 adult Bangladeshi people (50 males and 50 females) aged between 25 and 50 years were included in this study. The subjects of this study were selected from the Department of Radiology & Imaging of the same institution. Each participant was briefed about the total plan and purpose of the study. Then, each of them was advised by their physicians to do an x-ray of the left shoulder (anterior–posterior view), which was done in the Department of Radiology & Imaging. This procedure was done by using measurement tool box of DICOM software with angle option The measurement was recorded in degree. Only left scapula among the pair of the scapulae was selected for the study as per the Resolution of the 14th International Congress of Anthropology and Prehistoric Archaeology, held in Geneva, Switzerland in 1912.

Measurement of superior angle: The angle was measured on the A-P view of the left shoulder and measurement was taken in degree. This procedure was done by using measurement tool box of DICOM soft ware with angle option. The angle was measured from the lines joining from the medial border of the scapula where spine meets to the highest point of the superior border of the scapula, another line was drawn from the superior point of the scapula to the midpoint of the glenoid cavity, joining this two line form superior angle (Fig. 1).[3]

Measurement of inferior angle: It was measured by a line drawn from the most prominent point of the medial border of the scapula where spine meets the scapula to the bottom of the lowest point of the scapula and another line was drawn from the lowest point of the scapula to the infraglenoid tubercle, joining these lines was the inferior angle of scapula (Fig. 2).[3]

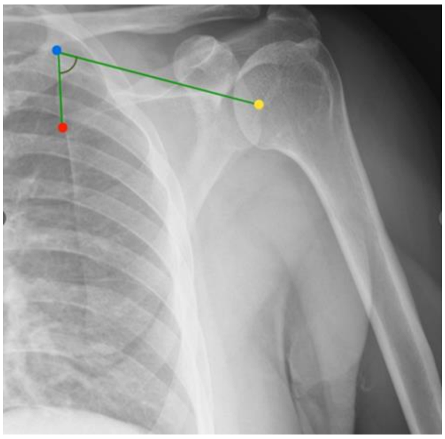

Fig. 1: Procedure of measurement of superior angle of left scapula (red dot: at the medial border of the scapula, where spine meets; blue dot: highest point of the superior border of the scapula; yellow dot: at the midpoint of the glenoid cavity)

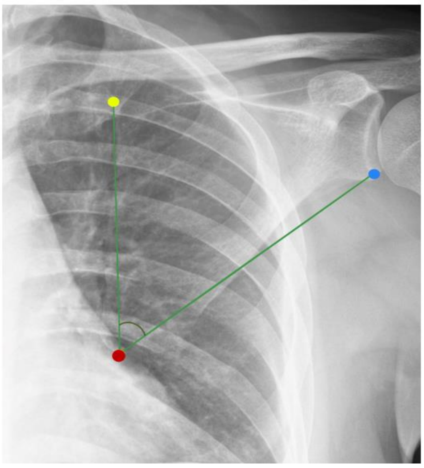

Fig. 2 : Procedure of measurement of inferior angle (red dot: at the lowest point of the scapula; blue dot: on the infraglenoid tubercle; yellow dot: on the most prominent point of the medial border of the scapula).

Measurement of lateral angle: The lateral angle was measured by a line drawn from the highest point of the superior border of the scapula to the midpoint of the glenoid cavity and another line was drawn from the midpoint of the glenoid cavity to the lowest point of the scapula, joining these two lines was lateral angle of scapula (Fig. 3).[3]

Measurement of gleno-polar angle: The gleno-polar angle was measured by a line connecting the most superior point to the most inferior point of the glenoid cavity and another line connecting the most cranial point of the glenoid cavity with the most caudal point of the scapular body, joining between these two lines was gleno-polar angle (Fig. 4).[5]

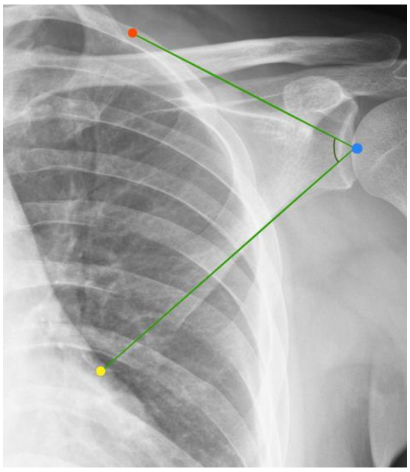

Fig. 3: Procedure of measurement of lateral angle (red dot: at the highest point of the superior border; blue dot: on the mid point of the glenoid cavity; yellow dot: to the lowest point of the scapula).

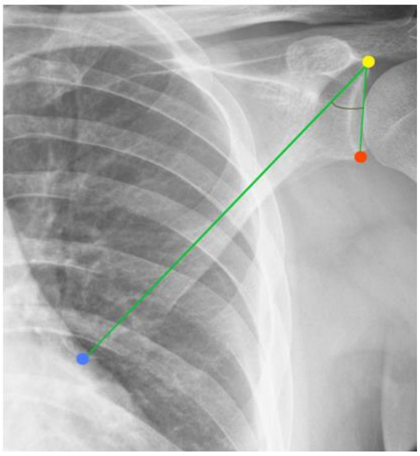

Fig. 4: Procedure of measurement of gleno-polar angle (red dot: most inferior point of the glenoid cavity; blue dot: at the most caudal point of the scapular body; yellow dot: most superior point of the glenoid cavity).

All data were checked and edited after collection. Statistical analysis was done by using Statistical Package for Social Sciences (SPSS) version 29.0 for Windows. Statistical tests such as Unpaired Student's 't' tests were done to see the difference between male and female scapular angles. Statistical significance was accepted at p- value equal to or less than 0.05.

The study was approved by the Ethical Review Committee of Dhaka Medical College, Dhaka, Bangladesh.

Results

The range of superior angle of left scapula was 68.70˚ to 78.20˚ and the mean was 73.30˚ ±2.88 in male and in female, the superior angle of left scapula ranged from 61.20˚ to 72.30˚ and the mean was 66.87˚±2.85. The difference was statistically significant (p<0.001) (Table-I). In male, the inferior angle of left scapula ranged from 41.20˚ to 50.20˚ and the mean was 46.01˚±2.37. In female, the inferior angle of left scapula ranged from 40.50˚ to 48.40˚ and the mean was 44.75˚±2.10. The mean value was significantly higher in male than that of female (p<0.05) (Table-I). The range of lateral angle of left scapula was 65.30˚ to 75.60˚ and the mean was 71.20˚±2.94 in male, while in female, the superior angle of left scapula ranged from 62.20˚ to 72.80˚ and the mean was 65.63˚±3.27.

The difference between male and female was statistically significant (p<0.001) (Table-I). The gleno-polar angle of left scapula was ranged from 30.20˚ to 37.40˚ and the mean was 34.18˚±1.90 in male. In female, the gleno-polar angle of left scapula ranged from 28.40˚ to 35.50˚ and the mean was 33.33˚±1.57. The difference between mean gleno-polar angle of adult male and female left scapula was statistically significant (p<0.05) (Table-I).

Table- I: Superior angle, inferior angle, lateral angle and gleno-polar angle of left scapula in adult male and female (N=100)

Variables	Left Scapula		p-value
	Male (n=50) Mean±SD	Female (n=50) Mean±SD	
Superior angle (degree)	73.30±2.88 (68.20-78.20)	66.87±2.85 (61.20-72.30)	<0.001*
Inferior angle (degree)	46.01±2.37 (41.20-50.20)	44.75±2.10 (40.50-48.40)	<0.05*
Lateral angle (degree)	71.20±2.94 (65.30-75.60)	65.63±3.27 (62.20-72.80)	<0.001*
Gleno-polar angle (degree)	34.18±1.90 (30.20-37.40)	33.33±1.57 (28.40-35.50)	<0.05*

Figures in the parentheses indicate range. Comparison between male and female was done by unpaired Student's 't' test; * = significant.

Discussion

In our study, the superior angle of left scapula was 73.30˚ ±2.88 in male and 66.87˚±2.85 in female (p<0.001). There are very few studies about angles of the scapula where male and female values are measured. None of the earlier researchers measured it separately on the two sided bones. However, our values are in consonance with the findings of Solanki, who measured it in Indian population,[6] Our values are slightly higher comparing to the findings of Piyawinijwong *et al.*, who measured it in Thai population,[7] and lower than that of Coskun *et al.*, who measured it in Turkish population.[8] Thus, it indicates a strong racial and regional difference. Inman *et al.* stated that the superior angle provides the base for the upper force-couple for the elevation and the rotation of the scapula.[9] We found that the inferior angle of the scapula in male and female were 46.01°±2.37 and 44.75°±2.10 respectively ($p<0.05$). Our values are in consonance with the findings of Solanki,[6] but almost 1.5 times higher as comparing to that of Piyawinijwong *et al.*[7] This angle is the only angle that tends to undergo drastic changes during evolution.[2] Regarding the lateral angle of scapula, we observed 71.20°±2.94 in male and 65.63°±3.27 in female ($p<0.001$). Similar findings were reported by Solanki.6 Finally, measuring the gleno-polar angle was done based on the obliquity of glenoid articular surface in relation to scapula body. We found 34.18°±1.90 in male and 33.33°±1.57 in female ($p<0.05$). Similar observations were reported in some of the previous studies.[10-12] Evidence revealed that for deciding the treatment and observing the prognosis of floating shoulder, which is ipsilateral fracture of mid shaft of clavicle and neck of glenoid, the knowledge of gleno-polar angle is very important.[9,11,13] This findings of this study are expected to provide a different perspective on designing products in the medical industry, especially in plastic or metallic implants for using in orthopaedic surgeries.

Our study has some limitations. A relatively small sample size in a certain region of the country may limit generalizability to other settings. The cross-sectional nature prevents causal inferences about observed associations. Therefore, future research should employ longitudinal designs with larger, more diverse samples for better understanding the in this context.

Conclusion

In the present study, significantly larger values of the superior, inferior, lateral and glenopolar angles of the left scapula were found in male comparing to its female counterpart. The findings of the study might offer support for improved implant design in the context of Bangladeshi people's shoulder joint replacement and repair.

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