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Original Article

Anatomical Variation of Sternal Angle and Body: a Cross sectional study

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Abstract:

Background: The sternum is one of the important skeletal components ofthoracic case that frequently has congenital defects, and researchers routinely use variances to ascertain an individual's age and sex. Additionally, it helps the physician with biopsy procedures as well as therapy. The objective of this study was to evaluate the morphological characteristics of sternal body and sternal angle in both sexes.

Method: This cross-sectional stuywas carried out at the Department of Anatomy, Sylhet MAG Osmani Medical College. For this purpose, 100 dried ossified sternums of unknown sex had been collected. The sample was collected in compliance with the inclusion and exclusion criteria. Discriminant function analysis was used to determine the sex of each sternum (DFA). Study variables were the maximum length of sternal body, maximum breadth of sternal body, thickness of the sternal body and sternal angle. Variables were measured using a vernier caliper and documented in a pre-designed data sheet.

Result: The mean length of the body of sternum was 93.84±23.31 mm in male and 82.84±14.8 mm in female. The mean width of the body of the sternum was 35.3±10.83 mm in male and 29.22±9.65 mm in female. The thickness of the body of the sternum is 19.86±9.91 mm in males and 16.12±7.39 mm in females. Analysis revealed that length of body sternum, width of body of sternum and thickness of body of sternum were higher in male than female which was statistically significant ($p<0.05$).The mean angle of sternum was 148.29±8.240 degrees in males and 149.32±9.690degrees in females, respectively. The difference was statistically not significant ($p<0.05$).

Conclusion: In females, the maximum sternal length, maximum sternal breadth, and maximum sternal thickness were all significantly lower.

Key words: body of sternum, sternum, morphometric study, variation, vernier caliper, discriminant function analysis (DFA)

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Introduction:

The sternum is Located in the center of the chest, often known as the breastbone, is a long, flat bone.

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By forming the front of the rib cage and joining the ribs via cartilage, it helps to shield the major blood vessels, lungs, and heart from trauma and injuries.[1]Understanding the morphometrics of the sternum is important for various therapeutic settings, including thoracic, vascular, and cardiac surgery.[2] The clinical significance of the sternum is also apparent during cardiac resuscitation procedures. Active compressive-decompressive cardiopulmonary resuscitation, which involves artificial breathing and heart massage, frequently results in sternum fractures. Breaks sustained during this course of therapy have the potential to cause significant heart damage, frequently leading to death.[3]

The manubrium and the sternum's body articulate above to form the manubriosternal joint, commonly known as the Louis angle or sternal angle (LA). This is felt as a transverse bony ridge on the sternum's front surface. The intervertebral disc between the T4 and T5 vertebrae is where the sternal angle is located.[4] Numerous anatomical structures, including the

beginning and termination of the aortic arch and the bifurcation of the trachea into the left and right major bronchus, are marked by this significant surface bony landmark.[5] The sternum's body, which is its greatest portion, is flat and lengthy. It articulates inferiorly with the xiphoid process and superiorly with the manubrium. Several articular facets identify the body's lateral edges. Three complete facet for the third through sixth costal cartilages and two demi facet for the second and seventh costal cartilages make up the lateral border.[6]

Data regarding the morphology and morphometry of the sternum are still lacking. Thus dry ossified sternum was used in my work so that morphometric analysis could be further assessed.

Methods:

This cross-sectional study was carried out from July 2021 to June 2022, at the Department of Anatomy, Sylhet MAG Osmani Medical College, Sylhet. The technique of purposive sampling was used for collecting data. One hundred dried ossified sternums of both sexes were selected for the study purpose. The research protocol was approved by the Ethical Committee of Sylhet MAG Osmani Medical College, Sylhet.

In order to fulfill the inclusion criterion, 100 dried ossified sternums of adults with intact manubriosternal joint, age ranged from 40 to 70 years, were obtained from the Department of Anatomy at the Sylhet MAG Osmani Medical College, Sylhet. Any sternum with developmental anomaly were excluded from the study. The discriminatory function analysis (DFA) method was used to determine sex. It is a statistical method employed to assess the precision of a specific classification system[7].Using this method, the sex was ascertained and the grouping was carried out. There was a marginally higher propensity for the males to be correctly classified. Approximately 79% of sternums were correctly classified by DFA (79.2% of males and 78.8% of females), while approximately 76% of cases were appropriately allocated to their correct sex on cross-validation. The study variables were the maximum length of sternal body, maximum breadth of sternal body, thickness of sternal body and sternal angle. Variables were measured by using a vernier caliper. Length was measured from the midpoint of the upper border of the body of the sternumto the midpoint of the lower border.The measurement of the body breadth and thickness was taken at multiple points: midway between the second and third, third and fourth, fourth and fifth, fifth and sixth, and midway between the sixth and seventh costal notches. Their average were calculated. The sternum will be positioned and stabilized at the proper angle in the lateral plane during the measurement of the sternal angle. The locations were noted exactly below the sternal synchondrosis (manubriosternal joint), next to the lower end of the clavicular notch, and below the lower end of the fourth costal notch on the side below the sternum, near to the sternum posterior surface. By connecting the places indicated on the subsurface with lines, the sternal angle can be calculated. A protractor was used to measure the sternal angle. The data was processed and analyzed by using the SPSS (Statistical Package for Social Sciences), version 22.0. Independent sample 't' test was used for data analysis. Tables and diagrams were used fordata presentation.

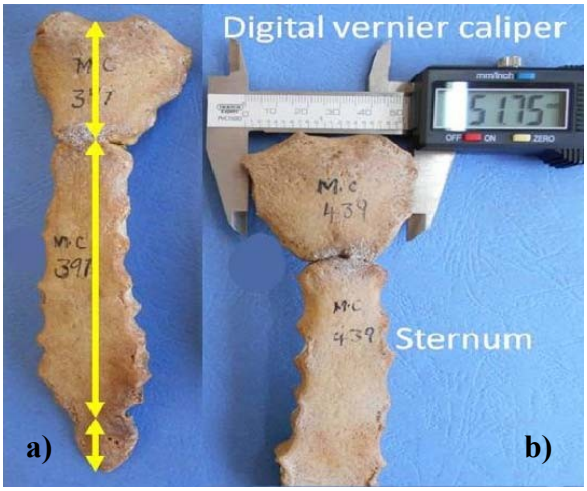

Figure 1: a) Procedure of measurement of length of the sternum
b) Procedure of measurement of width of the sternum

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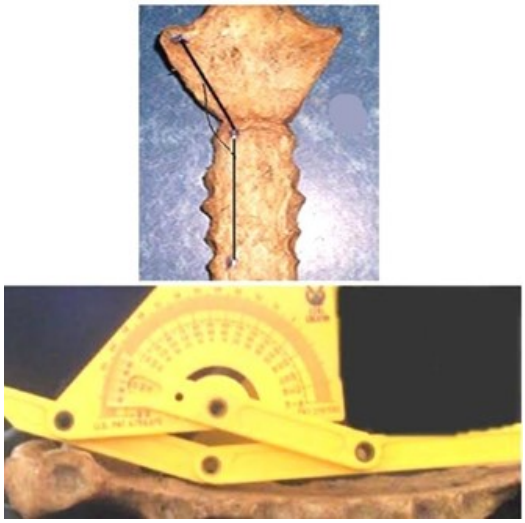

Figure 2: Procedure of measurement of sternalangle

Results

Figure 1 shows the mean age of male sternum was 55.6±7.56 years and female was 57.84± 5.55 years. The difference were non-significant. The mean length of the body of sternum was 93.84±23.31 mm in male and 82.84±14.80 mm in female with a range of 64.06–130.39 mm. The mean width of the body of the sternum was 35.30±10.83 mm in male and 29.22±9.65 mm in female with a range between 21.31-60.84 mm.Thethicknessofthebodyofsternumis19.86±9. 91 mm in male and 16.12±7.39 mm in female witharangeof6.82–48.84 mm. All the variables were higher in male (Table 1). Theme an angle of sternum was148.29±8.24^0 in male and 149.32±9.69^0 in female witharangeof129°-162°. The difference was statistically not significant between male and female (P<0.05) (Table 2).

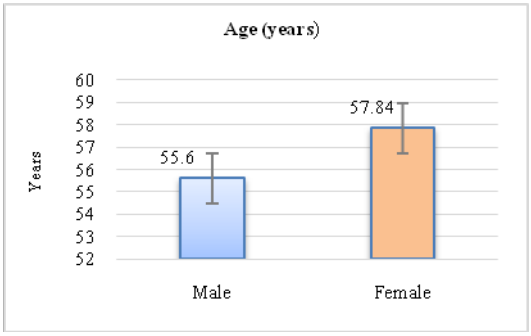

Figure 3: Age of the male and female sternum (years)

Table 1: Measurement of the Length, width andthicknessofbody of sternum according to sex (N=100)

Variables	Male (n=48) Mean±SD (mm)	Female (n=52) Mean±SD (mm)	*P* value
Length of body of sternum	93.84±23.31 (66.13-130.39)	82.84±14.80 (64.16-120.35)	0.001***
Width of body of sternum	35.30±10.83 (23.6-60.84)	29.22±9.65 (21.31-53.3)	0.004**
Thickness of body of sternum	19.86±9.91 (10.6-48.84)	16.12±7.39 (6.82-38.36)	0.034*

*** - highly significant. * - significant.

Statistical analysis was done by independent sample't' test. Values in the parenthesis indicate range.

Table2: Statistical analysis of the measurement of the sternalangle (N=100)

Variables	Male (n=48) Mean±SD (^{0})	Female (n=52) Mean±SD (^{0})	P value
Sternalangle	148.29±8.24 (129-160)	149.32±9.69 (132-162)	0.443^{ns}

NS- non-significant.

Statistical analysis was done by independent sample't' test. Values in the parenthesis indicate range.

Discussion

The ability to tolerate thoracic injuries may be impacted by changes in sternum anatomy. The aged population is more susceptible to thoracic injuries due to their increasing fragility and weakness, which also raises the risk of death and morbidity.[8]

The age difference of the studied sternum in this study showed no significant difference.

This study shows the mean length of the body of sternum was 93.84±23.31 mm in male and 82.84±14.80 in female with a range of 64.06–130.39mm. The mean width of the body of the

sternum was 35.30±10.83 mm in male and 29.22±9.65 mm in female with a range between 21.31–60.84mm.The thickness of the body of sternumis19.86±9.91 mm in male and 16.12±7.39 mm in female witharangeof6.82–48.84mm. Analysis revealed that length of body sternum, width of body of sternum and thickness of body of sternum were higher in male than female which was statistically significant between male and female ($p<0.05$). Similar findings were reported in a study conducted in India.[9]

Sternal angle has its importance in both anatomical as well as clinical view. In this study, themeasurementofthesternalangle.Themeanangle ofsternumwas148.29±8.24^0 in male and 149.32±9.69^0 in female witharangeof129°-162^0.The difference was statistically not significant between male and female ($p<0.05$). But the result was not consistent with a studies conducted In India by Ateşoğlu, Deniz and Uslu., 2018.[9]In that study the mean sternal angle in male were 163.75 ± 5.79^0 and female were162.21 ± 6.17^0. The difference of the mean angle of their study showed no significant difference. Kirum et al. (2017) observed that the mean angle for the sternum was 163.4 ± 6.7^o in males and 165.0 ± 6.4^o in females. Their results were also non-significant ($p = 0.481$).[10]

The study had several limitations. The study had a limited sample size and a short duration. It is advisable to conduct future research with a bigger sample size that encompasses diverse ethnic groups dwelling in various regions of Bangladesh.

Conclusion

The maximum length of sternal body, maximum breadth of sternal body, thickness of sternal body were significantly lower in female compared to male. But sternal angle between male and female showed no significant changes in our study.

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