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# Anatomical Variation of Sternal Angle in Adult Human Dry Sterna

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**ABSTRACT**
Sternal angle is a secondary cartilagenous joint between manubrium and body of sternum which lie at the level of lower border of T4 a few centimeters (5cm) below the sternal notch .The sternal angle is an important landmark for many anatomical points and is a point where costal cartilage of 2nd rib articulates with the sternum. Other events occurring at sternal angle are:-
1.Formation of cardiac plexus,
2.The upper limit of base of heart ,
3.Tracheal bifurcation ,
4.Start of ascending and descending aorta,
5.Demarcation of superior and inferior mediastinum.Anatomical variations of the sternal angle are unique happeningshaving major clinical significance .Any misplaced sternal angle may cause inaccurate counting of ribs as first rib would be impalpable.It can also create challenge with intercostal nerve block and needle thoracostomies .The aim of this study is to determine the anatomical variation of sternal angle on dryhumansterna and to study its clinical significance as any anatomical variation of sternal angle may cause increase in inspiratory volume, increase risk of sternal fracture during trauma and cause serious complications like cardiac temponade pneumothorax and great vessel injury etc

**METHOD AND MATERIAL**
This was a descriptive cross sectional study in which the total of 25 adult dry human sterna were studiedat the Department of Anatomy, GMC Jammu.The measurements of sternal angle were recorded.Thequantitative and qualitative data were collected.

**RESULTS:**No significant difference was found in the mean size of the sternal angle in males and females.the mean size of sternal angle In males was170+SD3.17 and the mean size of the sternal angle in females was 168+4.7(p 0.118).The most frequent anamolyencountered in our study was bifid xiphoid process(4/25) .Among the 25 sterna two sternum were found with foramina in lower part of mesosternum and the manubrosternum junction of two sternum was fusedat the Department of Anatomy, GMC Jammu.

**CONCLUSIONS**:- The present study concluded to determine the accuracy of clinical and other procedures in the thoracic region. The anatomical variations of sternal angle may cause decrease in inspiratory volume,increases the risk of sternal fracture during trauma and can lead to serious complications like cardiac temponade, pneumothorax , great vessel injury etc

**Keywords;**Mesosternum,bifidxyphoid,foramina,thoracotomies

## I. INTRODUCTION

the sternum is a flat bone located in the middle of the chest cavity which forms part of the anterior thoracic wall.The sternum develops from two longitudinal mesenchymal bars,which appear during the 6th week of intrauterine life located at both sides of anterior chest wall.These bars migrate and fuse craniocaudally at the midline, to form the cartilaginous sternum by 10th week of intrauterine life.The ossification of the cartilaginous sternum is completed from multiple ossification centersthat appeared in a craniocaudal line at the manubrium,the sternal body and xiphoid process. The ossification centerfor manubrium appear at 3rd – 6th intrauterine month and the paired ossifications centers of the sterna body appear at 1st year of life. They develop into four transverse segments called sternebrae. The xiphoid process has one or two ossification centerswhich appears in the 1st decade of life.

Sternum consists of three parts: manubrium, body and xiphoid process. the manubrium, the superior part of the sternum, is

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located anterior to third and fourth thoracic vertebrae and is triangular in shape. The body of the sternum is located anterior to fifth and ninth thoracic vertebrae. It is longer, slender and narrower than the manubrium, but its width varies owing to the scalloping of its lateral borders by the costal notches. The xiphoid process is a thin sword-shaped process and is the smallest and most variable part of the sternum. Its caudal end is related to the central tendon of the diaphragm and inferior border of the heart.The manubrium and body of the sternum project in slightly different planes; hence, their junction forms a projecting sternal angle or angle of louis.

The sternal angle is a secondary cartilaginous joint between manubrium and body of sternum which lies at the level of lower border of T4 a few centimetres(5cm) below the sternalnotch.Itis an important clinical landmark for many anatomical points and the costal cartilage of 2nd rib articulates with sternum at this point.Other events that occur at sternal angle are demarcation between the superior and inferior portion of the mediastinum, passage of the thoracic duct from right to left behind esophagus,formation of tracheal bifurcation, end of the azygos system into superior vena cava, ligamentumarteriosum, loop of left recurrent laryngeal nerve around aortic arch, aortic arch starts and end at this point.

Anatomical variations of the sternal angle are unique happenings of major clinical significance. For instance, a misplaced sternal angle may cause inaccurate counting of ribs thereby complicating intercostal nerve blocks, needle thoracostomies and physical examination of the chest. A misplaced sternal angle is also associated with increased risk of sternal fractures in blunt chest trauma.The variation may influence clinical procedures and diagnostis such as intercostals nerve block, interpretation of sternal images and evaluation of chest trauma.

**AIMS AND OBJECTIVES**

1.To determine the anatomical variation of Adult dry human sterna

2.To study the clinical significance of sterna angle

## II. MATERIALS AND METHODS

The prospective observational study was conducted in the postgraduate department of Anatomy, Government Medical College, Jammu. A total of 25 dry human sterna were studied.

The following parameters were measured in the sudy: The sternal angle was measured on a flat surface using three landmarks:

1.A point immediately below the inferior end of clavicular notch,

2.One immediately below manubriosternal junction and

3.A point inferior to the 4th costal notch .

The Vernier calliper was used to measure the distance between the mentioned points.Two lines were drawn to join these points and the angle subtended was measured.Manubrium length was measured from the center of the jugular notch to thecenter of the manubrosternaljunctionby using a vernier caliper. All the measurements were taken two times to prevent the measuring errors. The data was recorded and analysed through descriptive statistics. Any angle out of the reference interval of $155^0$ - $175^0$ and any manubrium longer than 58.8 mm in males and 56.9 mm in females were considered increased and abnormally long respectively . The location of the angle and number of sternal symphyses were also recorded.The sternal angle was considered misplaced if it did not correspond with the second costal notch..The sex differences were determined using independent students' t-test and a p value of $\leq$ 0.05 was considered significant.

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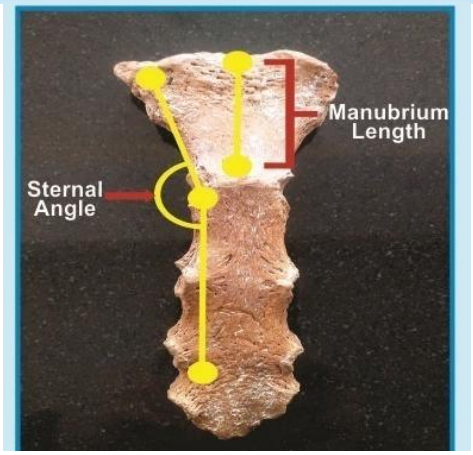


**INCLUSION CRITERIA**
1.Adult dry human sternum
**EXCLUSION CRITERIA**
1.Pathological changes
2.Broken or lacerated sternum

## III. LIMITATIONS

This study was limited by a small sample size which may affect the generalizability of our finding. Being an institution based study, the findings may not represent a good picture of the community hence anatomical variation of the sterna angle may be under or over reported since potential cases of variation.A non-random sample was used due to limited specimens in institution.This may introduce selection bias in the study, similarly leading to over or under reporting of sternal angle variations.

## IV. DISCUSSION

The findings of the present study were discussed with literature.The literature of present study suggests that the awareness ofanatomicalvariation played a key role for acupuncture, nerve block and thoracostomies.

There was no significant difference found in the mean size of the sternal angle in males and females.The mean size of sternal angle In males was170+SD3.17 and the mean size of the sternal angle in females was 168+4.7(p 0.118).The most frequent anamoly encountered in our study was bifid xiphoid process(4/25) .Among the 25 sterna two sternum had also foramina in lower part of the mesosternum and the manubrosternum junction of two sternum was completely fused

A review of literature found three studies that have documented the size of the sterna angle, one in Kenya, second in croatia and the third in Ugandans.

In study conducted by Selthofer et al in Croatians measuring the mean sterna angle for males was 7.4 and female was 7.2 respectively .The other study conducted by EL.Busaidy et al in Kenyans measuring the mean sterna angle for males was 6.0 and for females was5.9 respectively.

In similar study conducted by G.G.Kirum et al in Ugandans reported that the mean for males and females was 6.7 and 6.4 respectively.The variant sizes of the sternal anġleacrosspopulation

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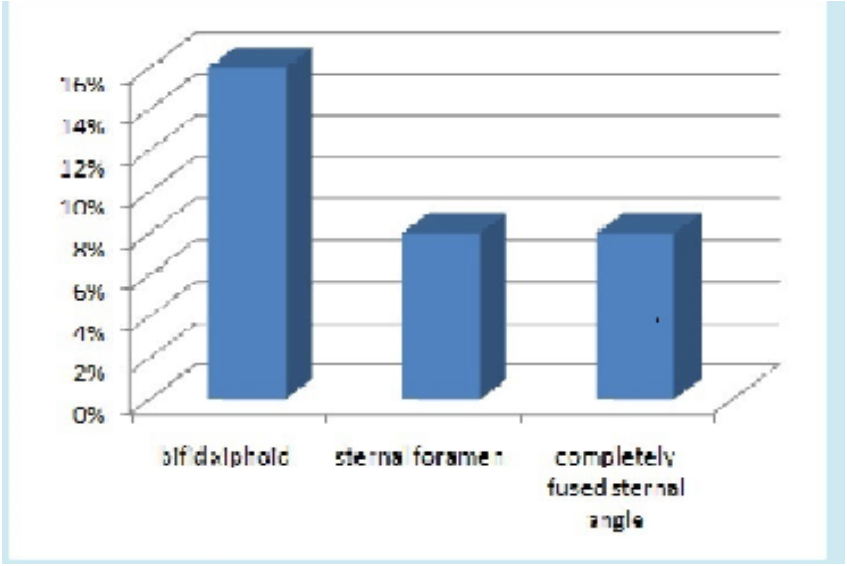
with uganda and kenyan sterna being smaller than croatian sterna

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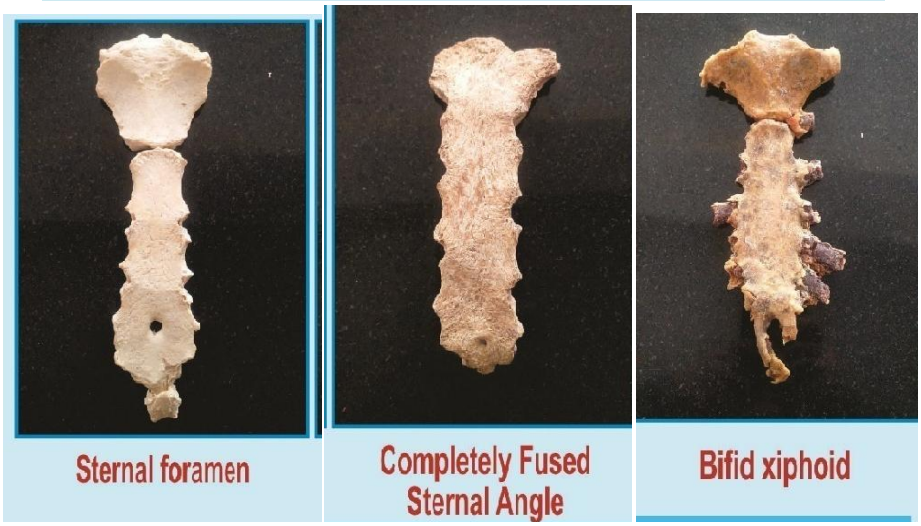


Table:1 Distribution of bone studied

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| 1 | 25 | 110 | 155 | 139.52 | 10.623 |
| 2 | 25 | 3.0 | 5.5 | 4.440 | .6602 |
| 3 | 25 | 3.1 | 5.4 | 4.344 | .6178 |
| 4 | 25 | 4.5 | 5.9 | 5.148 | .4302 |
| 5 | 25 | 160 | 176 | 169.44 | 4.063 |

Table:2 Gender wise Distribution of bone studied

| Gender | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| Males | 14 | 140.00 | 155.00 | 147.0000 | 5.34933 |
| | 14 | 4.00 | 5.50 | 4.8786 | .44752 |
| | 14 | 4.20 | 5.40 | 4.7500 | .43456 |
| | 14 | 4.70 | 5.90 | 5.3429 | .40519 |

| | | | | | |
|---|---|---|---|---|---|
| | 14 | 165.00 | 176.00 | 170.5714 | 3.17961 |
| Females | 11 | 110.00 | 135.00 | 130.0000 | 7.45654 |
| | 11 | 3.00 | 4.50 | 3.8818 | .41670 |
| | 11 | 3.10 | 4.20 | 3.8273 | .38234 |
| | 11 | 4.50 | 5.70 | 4.9000 | .33166 |
| | 11 | 160.00 | 175.00 | 168.0000 | 4.73286 |

Table:3Comparison of different parameters between males and females

| | V9 | N | Mean | Std. Deviation | Statistical Significance | |
|---|---|---|---|---|---|---|
| | | | | | t-value | p-value |
| 1 | 1 | 14 | 147.00 | 5.349 | 6.642 | <0.001 |
| | 2 | 11 | 130.00 | 7.457 | | |
| 2 | 1 | 14 | 4.879 | .4475 | 5.695 | <0.001 |
| | 2 | 11 | 3.882 | .4167 | | |
| 3 | 1 | 14 | 4.750 | .4346 | 5.550 | <0.001 |
| | 2 | 11 | 3.827 | .3823 | | |
| 4 | 1 | 14 | 5.343 | .4052 | 2.931 | 0.008 |
| | 2 | 11 | 4.900 | .3317 | | |
| 5 | 1 | 14 | 170.57 | 3.180 | 1.624 | 0.118 |
| | 2 | 11 | 168.00 | 4.733 | | |

## V. CONCLUSIONS

The present study concluded that for the accuracy of clinical and other procedures in the thoracic region. The anatomical variations of sternal angle may cause decrease in inspiratory volume,increases the risk of sternal fracture during trauma and can lead to serious complications like cardiac temponade, pneumothorax , great vessel injury etc

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