

AUTOPSY BASED REGIONAL STUDY OF DETERMINATION OF SEX FROM STERNAL FINDINGS*Krishnakumar Siva Sankara Narayanan¹, Prajith Thekke Madathil²*¹*Assistant Professor, Department of Forensic Medicine, Government Medical College, Kozhikode, Kerala.*²*Assistant Professor, Department of Forensic Medicine, Government Medical College, Kozhikode, Kerala.***ABSTRACT****BACKGROUND**

Establishing identity from skeletal remains is a real challenge in the field of Forensic Medicine. Determination of sex is statistically the most important critical step as it immediately excludes approximately half the population. Even though the bones showing sexual dimorphism such as skull and pelvis were studied extensively. Studies on sternum in this aspect were not much and most of them revealed racial and regional variations in the indices. So, the present study is an attempt to find out the significant traits for determination of sex if any, among population of north Kerala.

MATERIALS AND METHODS

This study was conducted on 100 sterna collected from identified corpses brought for medicolegal autopsy at Department of Forensic Medicine, Govt. Medical College, Calicut. Specimen sterna were collected from consecutive cases of male and female corpses of age above 25 years. Clear data regarding identity including age in completed years, was verified from next of kin.

RESULTS

The predictability of sexing from morphometrical assessment of manubrium was considerably low due to most of them (more than 90%) falling in the zone of overlap. The length of the mesosternum could sex 28% of population by binary regression using SPSS analysis. In case of combined midline length (of manubrium and mesosternum), the mean for male was 135.29mm and 121.44mm for female. 74% of the population showed the length to be in an overlap zone and could sex 16% specimens only using SPSS binary regression. The values observed in the present study were much lower than that for North Indian sterna, with a mean difference of 13.85mm. Only 17 out of 50 (34%) of female sterna had a combined midline length equal to or more than 126mm. Only 9 out of 50 (18%) of male sterna had a length equal to or below 126mm.

CONCLUSION

Among various parameters which showed lesser overlapping, the most common was combined midline length- 74%. If a cut of length of 126mm was chosen (midpoint of zone of overlapping,) 41 out of 50 male sterna (82%) and 32 out of 50 female sterna (64%) could be sexed. Over all sternum is a poor indicator regarding sexing if considered alone.

KEYWORDS

Sternum, Manubrium, Mesosternum, Combined Midline Length, Sternal Index, Identity and Autopsy.

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BACKGROUND

Establishment of identity of the dead is an essential objective of any post mortem examination. Whenever the soft tissue features are insufficient or undependable, identity depends solely on measurements and recognition of any pathological or anatomical peculiarities or abnormalities of bones, barring DNA analysis.

The determination of sex is statistically the most important critical step as it immediately excludes approximately half the population. Unfortunately, positive or

compelling evidence of sex in human remains is not always available. The body may be in advanced stage of decomposition or there may have been deliberate mutilation or only portions of a dismembered body may come to hand or only the skeleton or part of it may be available. In such cases the sex of an individual will have to be assessed solely from the materials in the forensic pathologist's possession. The value of this assessment will depend in part to the amount and nature of the available material and in part to the experience and judgement of the investigator. The more extensive the remains the more significant will be the conclusion. The less skilled the investigator in anthropology and less well read in its literature the greater the likelihood of error.

The accuracy of determination of sex from skeletal remains varies with age at death of subject, degree of fragmentation of bones and biological variability. Obvious sex differences do not become apparent until after puberty, usually in the age of 15 to 18 years, though specialized measurements on the pelvis are believed to indicate sex

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*Corresponding Author:
Dr. Prajith Thekke Madathil,
Assistant Professor,
Department of Forensic Medicine,
Government Medical College,
Kozhikode, Kerala.
E-mail: drprajithtm@gmail.com
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even in foetal material.¹ Some of the features may develop only still later and may be lost in advanced stage. Fragmentation may cause loss of these morphological features of the bone.

Of course, the classic features in the bone groups at either ends of the axial skeleton (skull and pelvis) as also the proximal bones of the lower limbs place them better position to comment upon age, sex and ethnic features of identity and are studied extensively; nothing prevents from exploring the possibility of evaluating other bones too for the purpose. One such bone, less explored is the sternum-the chest bone-shielding the heart. Floating for most of its part, supported mostly by costal cartilages on the sides, the sternum is unique in the human body. The possibilities of this bone which is easily available during exploration of the body, sufficiently large to have dimorphism of features and not to be lost during excavations are attempted to be studied, for some of its features could offer assistance in identity studies.

A difference in the ratio between the length of the manubrium and that of mesosternum in the two sexes was first described by Wenzel (1788).² His findings were supported by Hyrtl (1853) and by Dwight (1890). For sexing the European sterna Asley (1956) formulated '149 rule'. According to which a male sternum exceeded 149 mm in length, whereas the female sternum was less than 149 mm.³ The present study is aiming to correlate different dimensions of sterna and sternal elements with sex in Malabar population.

Aims and Objectives

1. To collect 100 sterna from identified corpses of both male and female sex of 25 years and above (50 of males and 50 of females).
2. To measure and tabulate various dimensions and to calculate indices for features of sexual dimorphism from identified male and female sterna.
3. To compare these observations with those in the earlier works.

MATERIALS AND METHODS

This study was conducted on sterna collected from identified corpses brought for medico legal autopsy at Department of Forensic Medicine Govt. Medical College Calicut, where more than 1500 medico legal autopsies are done per annum.

Specimen sterna were collected from consecutive cases of male and female corpses of age above 25 years. Clear data regarding identity including age in completed years, was verified from next of kin.

Exclusion Criteria

1. Age or identity not confirmed by relatives.
2. Below the age of 25 years.
3. Defects, deformities or deficiencies, endocrine or others from the history given by the relatives and general examination.
4. Bodies with local bony trauma in the region of chest.

The bones were cleared of macerated tissue and air dried by suspending with cotton threads. The specimen sterna were stamped with identification number after drying and were subjected to measurements regarding sex differences.

To note sex differences, length and breadth of manubriae and mesosterna were measured (based on Anthropometry by Indira Devi) using a vernier calliper of least count fifty and zero error.

From the above measurements the sternal index was calculated

$$\text{Sternal (Manubrio Corpus) Index}^4 = \frac{\text{Length of manubrium}}{\text{Length of mesosternum}} \times 100$$

RESULTS

In the present study 50 male sterna and 50 female sterna collected from the dead bodies during medico legal autopsies, processed by allowing to decay in water, dried up and objectively studied. All the sterna were subjected to measurements. In those which showed excess lipping, exostoses or irregularity the breadth or length (of manubrium and mesosternum) could not be measured reliably and hence avoided.

Sex	No. of Cases	Percentage	Maximum (mm)	Minimum (mm)	Mean (mm)
Male	50	50	59.0	39.4	47.654
Female	50	50	54.4	35.5	43.969
Total	100	100	59.0	35.5	46.3

Table 1. Length of Manubrium (Male-Female Distribution Pattern)

The male manubriae showed a mean length of 47.654mm and the female 43.969. It was observed that though there was a difference of 3.695mm in the mean length between the male and female manubrium. There was a zone of overlapping from 39.4mm to 54.4mm (i.e.; the minimum length in male and the maximum length observed in the female). In fact, 92 cases out of 100 observed fell in this range (92%).

Sex	No. of Cases	Percentage	Maximum (mm)	Minimum (mm)	Mean (mm)
Male	50	50	64.5	45	54.34
Female	50	50	63.1	42	49
Total	100	100	64.5	42	52.24

Table 2. Breadth of Manubrium (Male-Female Distribution)

The male manubriae showed a mean breadth of 54.34mm and the female 49mm. Though there was a difference of 5.34mm between their mean breadths. There was an overlap between 45mm and 63.1mm (minimum breadth in males and maximum breadth in females). 96 out of 100 cases (96%) fell in this overlap zone.

Sex	No. of Cases	Percentage	Maximum (mm)	Minimum (mm)	Mean (mm)
Male	50	50	112.18	68.70	89.21
Female	50	50	96.3	62	77.48
Total	100	100	112.18	62	84.85

Table 3. Length of Mesosternum (Male-Female Distribution)

The male mesosterna showed mean length of 89.21mm and female 77.48mm. The difference was 11.73mm. the overlapping zone was between 68.7mm and 96.3mm (minimum length in males and maximum length in females). Overlapping is seen in 82% of the total specimen.

Sex	No. of Cases	Percentage	Maximum (mm)	Minimum (mm)	Mean (mm)
Male	50	50	54.8	23.76	37.75
Female	50	50	43	24.3	33.03
Total	100	100	54.8	23.76	35.99

Table 4. Breadth of Mesosternum (Male-Female Distribution)

The mean breadth of male mesosterna was 37.75mm and that of female was 33.03 mm. The difference was 4.72mm. The zone of overlapping was observed between 24.3mm (minimum breadth recorded in females) and 43mm (maximum breadth recorded in females)

Sex	No. of Cases	Percentage	Maximum (mm)	Minimum (mm)	Mean (mm)
Male	50	50	160.88	111	135.29
Female	50	50	141	101.6	121.44
Total	100	100	160.88	101.6	130.2

Table 5. Combined Length of Manubrium and Mesosternum (Male-Female Distribution)

The mean length in males was 135.29 mm and in females 121.44 mm with a difference of 13.85 mm. The zone of overlapping was between 111mm (minimum value noted in males) and 141mm(maximum value noted in females).74 out of 100 (74%)specimens fell in the zone of overlap.

$$\text{Sternal (Manubrio Corpus) Index} = \frac{\text{Length of manubrium}}{\text{Length of mesosternum}} \times 100$$

Sex	No. of Cases	Percentage	Maximum	Minimum	Mean
Male	50	50	76	39.9	54.06
Female	50	50	71.48	42.86	57.55
Total	100	100	76	39.9	55.37

Table 6. Sternal Index (Male-Female)

Mean sternal index in males was 54.06 and in females 57.55. The difference between these was 3.49. There was a zone of overlapping between 42.86(minimum value in females) and 71.48(maximum value in females).

100% of females and 90% of male specimens were in the overlapping zone: of the total number of cases 94% showed overlapping. Statistical significance was found to be low (P value=0.745).

DISCUSSION

Manubrium- The mean manubrial length observed was 46.3mm (47.65 mm for male with range from 39.4mm to 59mm; and 43.96mm for the female with the range of 35.5 to 54.4mm) 92 out of 100 of sternum fell in a zone of overlap.

The mean breadth of manubrium was 52.24mm (54.34mm for males and 49mm for females) 96 out of 100 cases fell in a zone of overlap.

The predictability of sexing from morphometric assessment of manubrium was considerably low due to most of them (more than 90%) falling in the zone of overlap.

Mesosternum- The mean length of mesosternum in the male was observed to be 89.21mm and in the female to be 77.48mm. 82% of male bones and 83% of female bones had a length of 68.7mm (lowest male value) and 96.3mm (highest female value). The length of the mesosternum could sex 28% of population by binary regression using SPSS analysis.

The mean breadth of male mesosterna was found to be 37.75mm in males (ranging from 23.76mm to 54.8mm) and in females the mean breadth was 33.03mm (ranging from 24.3mm to 43mm). On binary regression using SPSS

analysis breadth of mesosternum could sex only 19% specimens.

Combined Midline Length

In case of combined midline length (of manubrium and mesosternum), the mean for male was 135.29mm and 121.44mm for female.74% of the population showed the length to be in an overlap zone and could sex 16% specimens only using SPSS binary regression. For combined midline length of sternum, Ashley (1956) had postulated 'the rule of 149'as per which if the combined midline length exceeded 149mm it was a male and if below 149 mm it was a female, in case of European sterna. Jit and Kulkarni had postulated that for North Indian sterna it was more than149mm for males and less than 131mm for females. The values observed in the present study was much lower than that for North Indian sterna. Mean length of 135.29mm for male and 121.44mm for the female, with a mean difference of13.85mm was observed. Only 17 out of 50(34%) of female sterna had a combined midline length equal to or more than 126mm. Only 9 out of 50(18%) of male sterna had a length equal to or below 126mm.

Sex	Number of Cases	%
Male	41	82
Female	17	34

Table 7. Combined Midline Length- 126 cm or Above

It was thus presumed from the present study that the sternum though a bone which had attained credibility as to sexing by it various parameters by previous authors, by itself may not be relied up on because of the high biological variability observed.⁵ Of the various morphometric characteristics and indices the combined midline length appears to be the most useful one and 126mm is presumed to be a limiting line between the sexes.

Sternal Index (Manubrio Corpul Index)

As per Hyrtle’s (1853) law the ratio between the length of manubrium and that of mesosternum is more than 1:2 in case of women and less in men.^{6,7} The difference in two sexes regarding the ratio was first mentioned by Wenzel in 1788. The Hyrtle’ law was denied by Dwight and Krogman who claimed that it was 52:100 in women and 49:100 in men.

A poor discriminate.^{8,9}

Regarding the sternal index, it was observed that the ratio was higher in female as observed by the previous researchers also but was much different.

Manubrio-Corpul Index	Stieve and Hintzsche	Present Study
Male mean	46.13	54.06
Female mean	56.55	57.55

Table 8. Manubrio-Corpul Index

In the population studied, the sternal index had poor discriminate value (statistical significance being only (0.745).

CONCLUSION

1. In the population studied, direct parameters like length and breadth of manubrium and mesosternum, showed heavy over lapping, more than 90% of population existed in this zone of overlap.
2. Among the parameters which showed lesser overlapping the most common was combined midline Length- 74%. If a cut of length of 126mm was chosen (midpoint of zone of overlapping) 41 Out of 50 male sterna (82%) and 32 out of 50 female sterna (64%) could be sexed.
3. Over all sternum is a poor indicator regarding sexing if considered alone. The limitation of the study is that in included only a population of a particular region. So, it cannot ensure the reliability of application in other population or in general.

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