

GENDER DIFFERENTIATION OF ADULT HUMAN THROUGH MESOSTERNUM: AN AUTOPSY BASED STUDY.Maryam Shahid¹, Kanwal Zahra², Arif Rasheed Malik³**ABSTRACT**

Objective: To identify the genders by using Mesosternum measurements and to evaluate the difference between males and females by discriminant function analysis. **Material and Methods:** This predictive modelling study was conducted on dead bodies which were received at Department of Forensic Medicine and Toxicology, King Edward Medical University Lahore for medicolegal examination. Female and male dead bodies with fully intact Mesosternum having age 18 to 60 years were studied. After placing the dead body on autopsy table thorax was dissected by using linear midline incision (from chin to pubic symphysis) by standard autopsy blade. After reflecting the skin along with muscles from chest cage, clavicles were disarticulated from the sternum. Sternal margin of Mesosternum which articulate with cartilages of first seven pairs of ribs were cut carefully by bone cutter. After removal of sternum from thoracic cage it was washed, soft tissue scrapped and the sternal measurements were taken in millimetres with Vernier calliper. Measurements were taken by placing the bone on a flat surface and after taking measurements bone re-placed at its anatomical position. **Results:** There were 45(52.94%) male and 40(47.06%) were female. Mean age of all cases was 36.02±11.79 years. Overall mean of Mesosternum (mm) length in male and female was 106.86±5.73 and 98.43±5.95 mm respectively. Measurements of Mesosternum were significantly high among males as compared to females (p=0.001). Discriminant function analysis evaluated and written as $DF=0.517 \times MSL$ 0.517. The overall accuracy by discriminant function analysis was 88%, while 93.3% accuracy in males and 82.5% in females was established. **Conclusion:** This study observed that the average length of the Mesosternum (mm) was markedly high among males as compared to females. A Discriminant function equation was devised which may be useful for sexual estimation of unknown Mesosternums.

Keywords: Gender, Mesosternum, Discriminant Function Analysis.

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INTRODUCTION

Identification is recognition of a person and human being by means of physical and biological parameters.¹ Identity of a person is very important both in life and death and it is equally important in Forensic practice. Forensic experts use various parameters to establish identity and most important among them are age, sex and stature.² When criminal investigating agencies bring the human remains or decomposed bodies for examination, identification has utmost importance in such cases. so, role of Forensic experts is thus, determining identity, investigation of death, manner and cause of death. Identification is step by step process in which at first step the dead body is classified as male or female then individual assessment for making biological profile e.g scars, moles, tattoo marks, any deformity or congenital abnormality present on

body or skeleton.³ Bones act as support beams of

body and they also provide the information regarding adaptive mechanism to environment.⁴ Information about the parameters which are used to determine the individual identity such as age, sex, ancestry, stature can get from study and knowledge of bones.³ In process of identification bones and teeth play a key role to determine the gender, as both are made of more resistant tissues than any other part of body.⁵ Bone and teeth ultimately depict the functional dissimilarities which can alter genetic specifications of the both male and female.⁶ There are huge differences between two sexes such as males are having more robust facial and cranial features, larger stature, more muscularity and strengthen comparison to females and this is due to growth rates, hormonal effects and even, effect of increasing age on skeletal material but sometimes it shows false outcome.⁷ In different populations of world different bones have been used for gender

determination so far.⁸ Actively used and studied skeletal bones are pelvis followed by skull, then long bones followed by ribs, clavicle, sternum, vertebrae and bones of feet and hands.⁹⁻¹¹ In field of sex determination, some bones have received greater attention over others.¹² This study has been proposed to identify the genders of adult human via Mesosternum measurements and to evaluate the difference between males and females by discriminate function analysis.

MATERIAL AND METHODS

This predictive modeling study was conducted at department of Forensic Medicine and Toxicology, King Edward Medical University, Lahore, after approval of synopsis during one year from May 2017-May 2018. Non-probability, purposive sampling technique was used. Both female and male dead bodies received for medico legal examination with fully intact Sternum and age 18-60 years were studied. Dead bodies with intersex state, deformed sternum (congenital and acquired) and fractured sternum were excluded. After placing the dead body on autopsy table, thorax was dissected by using linear mid-line incision (from chin to pubic symphysis) by standard autopsy blade of PM40. After reflecting the skin along with muscles from chest cage, clavicles were dis-articulated from the upper part of sternum. Cartilages of 1st seven pair of ribs which articulate with sternal margins were cut carefully with bone cutter. After removal of sternum from thoracic cage it was washed, soft tissue scrapped and the following measurements were taken in millimetres with vernier caliper by placing the bones on a flat surface. Mesosternum (LB) was measured from the mesosternal joint to midpoint of xiphisternal joint. After taking the measurements, bone is replaced in thoracic cage at its anatomical

position. All the data was collected via study Performa \.

DATA ANALYSIS: Data was entered and analyzed through SPSS version 23. Quantitative variables like age, were analyzed as mean and standard deviation. Qualitative variable like gender was presented as frequency and percentage. All variables were subjected to Discriminate Function Analysis which discriminates between two sexes with higher percentage and shows accuracy of results.

RESULTS

Following are the results of present study, evaluated, calculated and analysed from the measurements of 85 mesosternal bones which were taken from cadavers received in Forensic Medicine department, King Edward Medical University for the purpose of autopsy. Out of all 85 cases, there were 45(52.94%) males and 40(47.06%) females. The mean age of all cases was 36.02 ± 11.79 years, and according to males and females was 37.29 ± 10.44 years and 34.60 ± 13.14 years respectively. Table 1 Mean Mesosternum (mm) length in male and female was 106.86 ± 5.73 and 98.43 ± 5.95 mm respectively. The mean Mesosternum (mm) is statistically significantly higher in male as compared to female cases, as p-value < 0.01. Table 2 Table -3 shows that model is best fitted as p value is <0.05. Original versus predicted group subjects in term of accuracy, sensitivity and specificity with Negative predicted value (NPV) and positive predicted value (PPV). The overall accuracy of classification is 88.2%, sensitivity is 93.3% and specificity is 82.5%. The PPV is 85.71% and NPV is 91.67%. Table 5.

Table -1: Descriptive Statistics of age in both males and females (n=85)

	Gender	Mean±SD	Minimum	Maximum
Age (years)	Male(n=45)	37.29±10.44	18	60
	Female (n=40)	34.60±13.14	18	60
	Total (n=85)	36.02±11.79	18	60

Table - 2: Descriptive Statistics of Mesosternum (mm) in both male and female cadavers(n=85)

	Gender	Mean±SD	Minimum	Maximum	p value
Mesosternum (mm)	Male(n=45)	106.86±5.73	95.0	117.1	<0.01
	Female (n=40)	98.43± 5.95	85.3	110.7	<0.01
	Total (n=85)	102.89±7.18	85.3	117.1	<0.01

Table - 3: Model Fitting(n=85)

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1	.653	35.173	1	.000

Table-4 shows group centroids, if someone’s score on discriminate function (DF) is closer to 0.679 then those answers are probably male. If person’s score is closer to -1.764, then the data came from female. In

practical terms, mean of two scores as cut-off centroid is

Table – 4 Functions at group centroids	
Gender	Function
	1
Male	.679
Female	-.764

$$cut\ score = \frac{0.679 - 0.764}{2} = -0.072$$

If an individual's score on DF is above -0.0426 then probably the person is female otherwise person is male.

Table - 5: Classification Results(n=85)					
Gender			Predicted Group		Total
			Male	Female	
Original	Count	Male	33	12	45
		Female	9	31	40
	%	Male	73.3	26.7	100.0
		Female	22.5	77.5	100.0

DISCUSSION

Identification mean the determination or establishment of individuality of the living or dead person mostly, Forensic Medicine specialists have to mostly depend upon the bones for establishing the identification. They are often required to estimate sex, age and stature of a person from dismembered body parts and bones. Constantly, gender age and stature are the important criteria's in the determination and establishing the identity of an individual. Gender determination of unidentified skeletal remains encountered in Forensic or Archeological situations, is one of the prime tasks of experts like Forensic Medicine experts & anthropologists, involved in such examinations However a number of bones like pelvis, femur and skull etc., have contributed significantly to this endeavor, these sex-specific or sex indicative bones may or may not always found. In such situations, Forensic specialist and anthropologists have to depend on other sexually dimorphic elements of human skeleton such as sternum.¹³ Sternum is a flat and sword shaped bone situated vertically in anterior and median part of thoracic cage. Sexual differences of human sternum was initially studied by Wenzel who stated that in measurements, mesosternum lengths of males are relatively longer than females, although manubrium has equal length in both sexes.^{14,15} It led to Hyrtl's law that " the body or mesosternum in the sternum of males is, at least, twice as long as the manubrium."¹⁵ In present study, there were 45(52.94%) male and 40(47.06%) female cases in this study. The mean age of all cases was 36.02 ± 11.79 years; the mean age of male and female was 37.29 ± 10.44 years and 34.60 ± 13.14 years respectively. Ekizoglu et al¹⁶ described the reliability and utility of sternal morphometric

analysis for gender determination in their study., they studied 443 subjects and out of them 202 were females with mean age of 45.6 years and 241 samples were of males with mean age of 54.4 years, while overall range of age was 30 to 60 years with mean of 44±8.1 years and they took large number of samples from different places of their area.¹⁶ Another recent study by Atesoglu S et al¹⁷ evaluated the gender-related changes and morphological characteristics in adult human sternum. It included 200 adults among whom 103 were females and 97 were males, aged between 18-87 years. His lower limit of age was in accordance with present study.¹⁷ Another study by Yonguc et al.¹⁸ aimed to estimate sex with sterna lengths included 95 subjects including 65 (68%) males and 30 (32%) females, the mean ages were 33.7±5.1 years for males and 32.3±5.8 years for females.¹⁸ Female cases are less because less number of female dead bodies were brought to department for autopsy and those bodies included that fulfilled the criteria. Moreover, difference of five dead bodies is non-significant. In present study, the mean mesosternum (mm) length in male and female was 106.86±5.73 and 98.43 ± 5.95 mm respectively. The mean Mesosternum (mm) was higher in male in comparison to female cases and difference was statistically significant as p-value < 0.01. Results of this parameter, Mesosternum were significant in sex estimation and it was in accordance with Ekizoglu study that showed it was statistically significant parameter but with different measurements with mean Mesosternum length 104.9±10.6 mm and 89.1±9.2mm in males and females respectively.¹⁶ The present study also has similar observations to the researchers who had different measurements but appreciated this parameter for sex estimation. Like Adhvaryu AV et al¹⁹ reported that the average length of the

Mesosternum was 92.11mm in males and 78.28 mm in females. On other hand Puttabanthi Set al²⁰ also conducted the study to evaluate the gender of unknown adult human sterna by using the Statistical analysis and they found average value of the Mesosternum 92.36 among males and 88.95 in females. All these measurements were different according to their population and different geographical zone but significantly higher in males as compared to females with (p-value<0.001) like present study. However the present study findings are dissimilar with Narayanan K Set al.²¹ who concluded that the length of sterna mesosternum cannot be considered reliable due to high percentage of overlapping cases in their study. Yonguc recorded the overall mean length of body of sternum was 110.8±12.9, with mean value of 117.1±8.6mm and 97.1±9.5 mm for males and females respectively and it was dissimilar to present study with higher measurements and overlapping.²² In present study the data was analyzed by discriminate function analysis that was successful method for sex estimation. It showed that overall accuracy of data was 88.2% with 93.3% and 82.5% accuracy in males and females respectively. Wilk's lambda made the basis of classification and showed significant result with p value <0.05. Regarding the DFA results of the females sterna, Ekizoglu showed the accuracy of 80.9% in his research work on Turkish population that was not much dissimilar to present study results.¹⁶ The results of Dahiphale regarding overall accuracy to classify both male and female sterna by DFA were in great proximity to present study which showed 89% overall accuracy. Whereas Mittal's study by applying discriminate analysis on Indian Haryana population showed overall 83% accuracy, in which 78% males and 88% females were accurately classified.²³ These results dissimilar from present study as it showed less accuracy in males and more accuracy in females in comparison to findings of the present study. For enhancement of accuracy in sex determination by sternum, Singh J et al¹³ in North West India used discriminant function analysis and got 82% males and 89% female accurately sexed and Bongiovanni's study on United States got accuracy of 80% in males and 88% in females.²⁴ These results were also dissimilar to present study as both showed high accuracy of sex estimation in female sterna and less accuracy to male sterna. The Turkish population showed 80.2% accuracy rate for males and 80.9% for females by discriminate function analysis, recorded by Ekizoglu et al.¹⁶ it showed less accuracy in determination of both male and female sterna contrary to present study. In discriminate function analysis for sex estimation, some studies were also done from various other skeletal elements other than sternum, with different degrees of accuracy like sternal end of the rib with accuracy 86.1% by Kocak, femur with accuracy of 67.5% to 92% in reference to different parameters estimated by

Soni G, mandibles with 85.4% accuracy and humerus with 88% accuracy by Wankhede and Soni G.²⁵⁻²⁸ but accuracy rates of sternal bones by applying discriminate analysis are relatively higher than these skeletal elements. Present study showed significant results with higher accuracy but result differences of present study with other studies may be due to different sample size, by using different sample techniques, length of study subjects and may be attributed due to the genetic, environmental factors, climate and nutritional differences which may affect these parameters as quoted by different research workers.²⁵⁻²⁷ Even ethnic differences within national population might affect the results as mentioned by researchers.¹⁶

CONCLUSION

There are definite osteometric differences between Mesosternum of males and females. Results of present study are promising and studied sternal variables, showed sexual dimorphism and in reference to discriminate function analysis, an accuracy rate varies from 82.5% to 93.3%. This study observed that the mean length of the mesosternum (mm) was significantly higher in male as compared to female. A Discriminate function equation was devised which may be useful for sexual estimation of unknown Mesosternums. These results can be applied for determination of sex from sternum with reasonable confidence and accuracy.

LIMITATIONS

The distinctiveness of an individual depends and varies as per racial, environmental and biological variations. This fact has been verified through differences in measurements and statistical results in different populations in previous studies. The Discriminate function analysis is population specific so results obtained in one region cannot be applied to other.⁹⁹

SUGGESTIONS

It is suggested that regional collaborations for in depth studies are essential in assessing the sex from skeletal elements. Future studies are suggested over larger population to ascertain the reliability of these criteria to determine the gender.

ETHICS APPROVAL: The ERC gave ethical Review approval

CONSENT TO PARTICIPATE: consent was taken from Police and next of kin.

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