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Original Article

An Autopsy-Based Correlation Study About Determination of Sex from the Width of S1 Segment of Sternum in the Central India Indore Region (M.P.)

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ABSTRACT

Determination of sex from the skeletal remains is of immense importance in the field of forensic medicine, physical anthropometry and anthropology. Various previous studies have demonstrated sternum as an important tool for the determination of sex. Sternum bone is very important bone for age and sex determination in the mutilated, fragmented bodies and in advance stage of decomposition. Exact determination of sex from skeleton has been a critical issue in medico-legal cases and the accuracy depends on the type of material available and methods applied. Sternum is a bone which is easily retrievable even from the advance decomposed body and also from the bundle of bone so it become a very important bone. Total 632 subjects, with 350 male and 282 female of the age >25 years, were taken in our study and data analysis was done using SPSS software and relevant statistical test was applied. In our study, bisexual variation in relation to width of S1 segment of mesosternum was found conclusive.

Keywords: Anthropometry, Bisexual variation, Decomposed body, Medicolegal case, Sex determination, Width of S1 segment

INTRODUCTION

Anthropometric studies of skeletal structures have provided important information for identification procedures. Post-mortem investigations of various skeletal elements provide important data for sex estimation. In cases of advanced destruction of skeletal remains, especially pelvis and craniofacial morphometric studies are frequently used methods [1-6]. Sternum is a bone which is easily retrievable even from the advanced decomposed body and also from the bundle of bone, so it becomes very important bone for sex determination in the advanced stage of decomposition and from mutilated, fragmented bodies. Thus, studies focusing on sternum have provided important information to forensic experts[7].

Identification of an individual is very important in criminal cases like assault, murder, rape, disputed paternity, impersonation etc. and in civil cases like marriage inheritance, disputed sex etc. “Article 6 of the Universal

Declaration of Human Rights" states that everyone has the right to recognition everywhere as a person before the law [8].

The main part of corpus delicti (i.e., the body of the offense; the essence of crime) is the establishment of the identity of the dead body [9,10,11].

This study is done in various region of India but is not done in central India (M.P.) region. It is an established fact that study of anthropometry has accurate result, standards vary according to different races and region, that is why this study is undertaken and sternum is selected for anthropometry to develop the standards which will be helpful to determine the age in central Indian population. Another purpose of the study is to derive a formula for this central Indian population in medico-legal cases.

MATERIAL AND METHODS

This is an observational cross-sectional based analytical study done in mortuary of the Department of Forensic Medicine and Toxicology, MGM Medical College, Indore (M.P.). The study was carried out over a period of 12 months from July 2016 to June 2017. Total 632 subjects consisting of 350 males and 282 females of the age >25 years were taken in our study and data analysis was done by using SPSS software and relevant statistical test was applied. In our study, bisexual variation in relation to length of manubrium S1 and S3 respectively.

Sternum showing any pathology, fracture, gross deformity or any missing part and body with unknown age will be excluded from the study. As routine protocol for opening the thoracic cavity during autopsy, the sternum was removed from the body by sectioning the costal cartilages just beside the costo-chondral junction. For estimation of sex, the elements of each sternum, i.e., width of S1 segment of sterni was examined.

Width of the Sternum at First Sternebra (SW1)

It was the distance at the level of line passing from the midpoint between the facet for the second and third costal cartilages on both sides of the bone.

OBSERVATION AND RESULT

Figure 1 and Table 1 and shows the regression analysis of gender versus width of first sternebrae (S1).

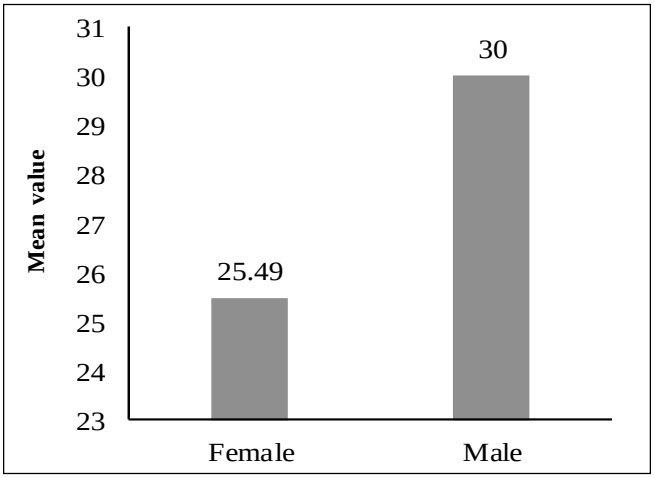

Figure 1: Cone diagram showing comparison of width of first sternebrae in relation to gender

Table 1: Regression analysis: Gender versus width of first sternebrae (S1)

	Coefficient	*'t'* value	*P* value
Constant	1.470	45.30	0.000*
Width of first sternebrae (S1)	0.002	3.22	0.001*

Regression analysis done. *F* value = 10.36, *P* value = 0.001*

The width of first sternebrae (S1) was found to be statistically significant ($P<0.05$), showing that width of first sternebrae (S1) will have meaningful addition to the model as changes in the predictor's value are related to changes in the response to variable.

Thus, width of first sternebrae (S1) is having importance for this model.

The regression equation obtained was:

Gender = 1.4706 + 0.002937 Width of 1st sternebrae (S1)

If the equation value nears 1, then the gender is female and if the equation value nears 2, then the gender is male.

The above Table 2 shows the discriminant analysis in finding out the gender based on the width of first sternebrae (S1).

Table 2: Discriminate analysis of gender based on the width of first sternebrae (S1)

Width of first sternebrae (S1)	True group	
	Female	Male
Female	219	191
Male	63	159
Total	282	350
N correct	219	159
Proportion	77.7%	45.4%
Overall proportion correct	59.8%	

Discriminant analysis used.

By this method, we were able to correctly identify 219 females and 159 males. The proportion of correct identification was 77.7% in females and 45.4% in males. The overall accuracy of this method was 59.8%.

Figure 2 is the ROC curve for the width of first sternebrae (S1). The width of first sternebrae (S1) is able to correctly identify the gender in 76.29% (Sensitivity) while it was able to correctly negate the gender in 52.84% (specificity). Though this variable is having a good sensitivity, but has very poor specificity, and also according to the ROC curve, this variable is not a very strong predictor of the gender (as the curve is not very near to the left hand border and left top border).

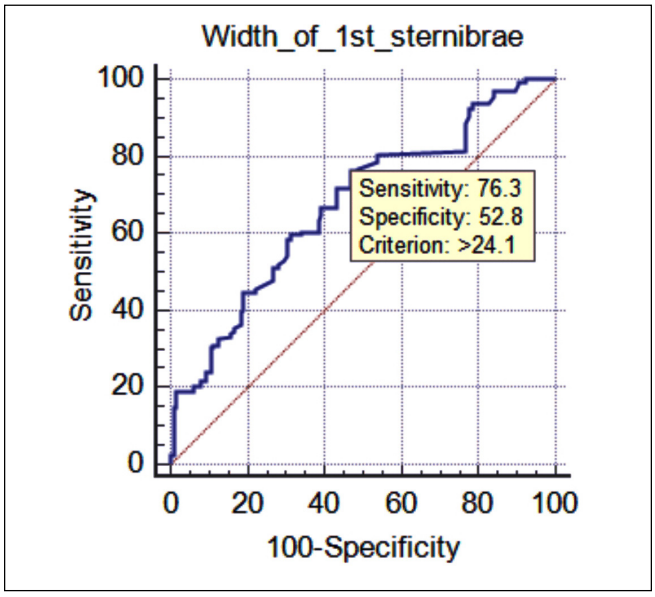

Figure 2: Width of First Sternibrae [ROC Curve]

Variable	Width_of_1st_sternebrae
Classification variable	SEX_1
Sample size	632
Positive group[a]	350(55.38%)
Negative group[b]	282(44.62%)
[a]SEX_1=Male [b]SEX_1=Female	
Disease prevalence (%)	Unknown
Area under the ROC curve (AUC)	
AUC	0.672
Standard Error[a]	0.0213
95% Confidence interval[b]	0.634 to 0.709
Z statistic	8.083
Significance level *P* (area=0.5)	<0.0001
[a]DeLong *et al.*, 1988 [b]Binomial exact	
Youden index	
Youden index *J*	0.2912
Associated criterion	>24.1
Sensitivity	76.29
Specificity	52.84

The cut-off value of width of first sternebrae (S1) is 24.1, i.e., if the width of first sternebrae (S1) is >24.1, then it is a male, else it is a female (Table 3).

DISCUSSION

In the present study, the discriminant analysis in finding out the gender based on the width of first sternebrae (S1). The proportion of correct identification was 77.7% in females and 45.4% in males. The overall accuracy of this method was 59.8%. Its regression analysis chart was found to be statistically significant ($P<0.05$) and hence concluded by regression equation that if the equation value nears 1, then the gender is female and if the equation value nears 2, then the gender is male. The ROC curve is able to correctly identify the gender in 76.29% (Sensitivity) while it was able to correctly negate the gender in 52.84% (specificity). The cut-off value of width of first sternebrae (S1) is 24.1, i.e., if the width of first sternebrae (S1) is >24.1, then it is a male, else it is a female.

Table 3: Comparison of SW1 by different author

Researcher	Sex (No)	SW1±SD (mm)	t-test
Dahiphale *et al*.[12] (Maharashtra)	M(96)	27.17±3.89	12.72
	F(47)	24.44±4.13	-1.96
Singh *et al*.[13] (North India)	M(252)	27.03±3.58	
	F(91)	23.11±2.85	
Puttabanthi *et al*.[14] (AndhraPradesh)	M(57)	53.32±13.50	
	F(22)	27.73±7.12	
Jitindar *et al*.[15] (Chandigarh)	M(312)	27.45±3.72	-1.35
	F(88)	24.32±3.94	-2.34
Fernandez *et al*.[16] (Spain)	M(43)	26.67±3.78	0.57
	F(40)	23.54±3.17	-0.73
Atal *et al*.[17] (Delhi)	M(50)	25.88±2.01	3.13
	F(50)	21.93±1.64	3.10
Ramadan *et al*.[18] (Turkey)	M(123)	28.7±3.8	5.28
	F(83)	25.2±3.3	3.07
Macaluso[19] (South Africa)	M(197)	34.9±5.9	-4.73
	F(143)	30.7±5.1	-5.70
Macaluso and Lucena[20] (Spain)	M(65)	28.31±3.28	
	F(51)	24.68± 4.43	
Changani *et al*.[21] (Saurashtra Region)	M(57)	27.8±3.71	
	F(26)	23.77±3.56	
Present study (central India Indore region)	M(326)	M(30.0±24.3)	-2.20
	F(142)	F(25.49±4.71)	

CONCLUSION

The comparison of mean width of first sternebrae in relation to gender shows that in females the mean width of first sternebrae was 25.49 ± 4.71 mm, while in the male it was 30.0 ± 24.3 mm. The difference was found to be statistically significant (P<0.05), showing a longer width of first sternebrae in the males in comparison to the females.

The discriminant analysis is used in finding out the gender based on the width of first sternebrae (S1). The proportion of correct identification was 77.7% in females and 45.4% in males. The overall accuracy of this method was 59.8%. Its regression analysis chart was found to be statistically significant (P<0.05) and hence concluded by regression equation that if the equation value nears 1, then the gender is female and if the equation value nears 2, the gender is male. And ROC curve is able to correctly identify the gender in 76.29% (Sensitivity) while it was able to correctly negate the gender in 52.84% (specificity). The cut-off value of width of first sternebrae (S1) is 24.1 mm, i.e., if the width of first sternebrae (S1) is >24.1 mm, then it is a male, else it is a female.

SUMMARY

Following summary was drawn based on the present study:-

(1) Width of first sternebrae:-

- The **mean width** of first sternebrae in relation to gender shows that in the females the mean width of first sternebrae was 25.49 ± 4.71 mm, while in the males it was 30.0 ± 24.3 mm.
- The difference was found to be statistically significant (P<0.05), showing a longer width of first sternebrae in the males in comparison to the females.
- The cut-off value of width of first sternebrae (S1) was calculated and observed to be 24.1 mm, i.e., if the width of first sternebrae (S1) is >24.1 mm, then it is a male, else it is a female.

- Regression equation formula for gender identification from length of 1st Sternebrae was derived as:-

Gender = 1.4706 + 0.002937 **width** of first sternebrae[S1]

If the equation value nears 1, then the gender is female and if the equation value nears 2, the gender is male.

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Conflict of interest:- Nil

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