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Original Article

An Autopsy-Based Study for Determination of Sex from the Length of Manubrium in the Central India Indore Region (M.P.)

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ABSTRACT

Skeletol remains or decomposed bodies are an important initial step in forensic investigation. Accurate determination of skeletal sex has been a critical issue in medico-legal cases and the accuracy depends on the nature 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 bones so it becomes very important bone for age and sex determination in the advanced stage of decomposition and from mutilated, fragmented bodies. Total 632 subjects, consisting of 350 males and 282 females above the age of >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 was found conclusive.

Keywords: Anthropometry, Bisexual variation, Sex determination, Sternum manubrium, Length, SPSS software, Skeleton remain

INTRODUCTION

Creation of an individual's biological profile is of extreme importance and depends on age and sex. The cranial and pelvic bones, in addition to the long bones, are important in estimating age and identifying the sex of an individual. Forensic experts are left with no choice but to depend on less sexually dimorphic elements of the human skeleton such as the sternum. Thus, studies focusing on sternum have provided important information to forensic experts [1].

Identity means the determination of individuality of a person based on certain physical characteristics, i.e., exact fixation of personality. "Article 6 of the Universal Declaration of Human Rights" states that everyone has the right to recognition everywhere as a person before the law [2].

Identification of dead body and proof of "corpus delicti" is essential and integral part of any criminal and civil justice delivery system throughout the world. The main part of corpus delicti (i.e., the body of the offence; the essence of crime) is the establishment of the identity of the dead body [3-5]. 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.

This study is done in various region of India but is not done in central Indian (M.P.) region. It is an established fact that study of anthropometry has accurate result, standards differs according to different races and different region, and it is advised that one should not use the study data of one place to other, 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 study is to derive a formula for this central Indian population in medico-legal cases.

The osseous skeleton of the sternum is the only structure which is observed to resist the effects of putrefaction and decomposition for a long period of time. Sternum is a bone which is easily retrievable even from the advanced decomposed body and also from the bundle of bones so it becomes a very important bone for sex determination in the advanced stage of decomposition and from mutilated, fragmented bodies.

MATERIALS AND METHOD

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.). 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 above the age >25 years were taken in our study and data analysis was done using SPSS software and relevant [6-8] statistical test was applied. In our study, bisexual variation in relation to length of manubrium was found conclusive.

Sternum showing any pathology, fracture, gross deformity or any missing part and body with unknown age will be excluded from the study.

As a 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., length of manubrium sterna was examined.

OBSERVATION AND RESULT

The above Figure 1 and Table 1 shows the regression analysis of gender versus length of manubrium (M) in mm.

The length of manubrium was found to be statistically significant [9] (P<0.05), showing that length of manubrium will have meaningful addition to the model as changes in the predictor's value are related to changes in the response variable.

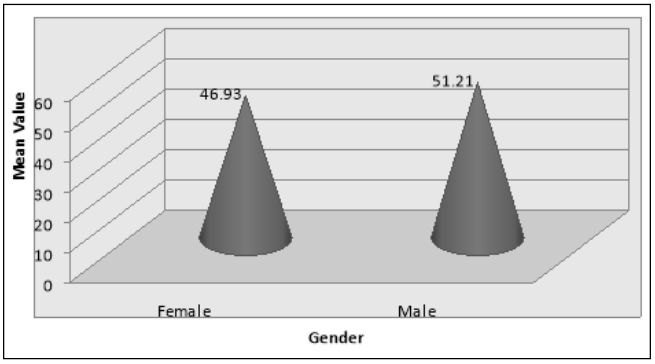

Figure 1: Cone diagram showing comparison of length of manubrium in relation to gender

Table 1: Regression analysis: Gender versus length of manubrium (M) in mm

	Coefficient	*'t' value*	*P value*
Constant	-0.422	-2.45	0.014*
Length of manubrium (M) in mm	0.040	11.55	0.000*

Regression analysis done. *F* value = 133.34, *P* value = 0.000*

Thus, length of manubrium is having importance for this model. The regression equation obtained was:

Gender = -0.422+0.04009 length of manubrium (M) in mm.

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 length of the manubrium (M).

By this method, we were able to correctly identify 220 females and 236 males.

Table 2: Discriminant analysis of gender based on the length of manubrium (M) in mm

Length of manubrium (M)	True group	
	Female	Male
Female	220	114
Male	62	236
Total	282	350
N correct	220	236
Proportion	78%	67.4%
Overall proportion correct	72.2%	

Discriminant analysis used.

The proportion of correct identification was 78% in females and 67.4% in males. The overall accuracy of this method was 72.2%.

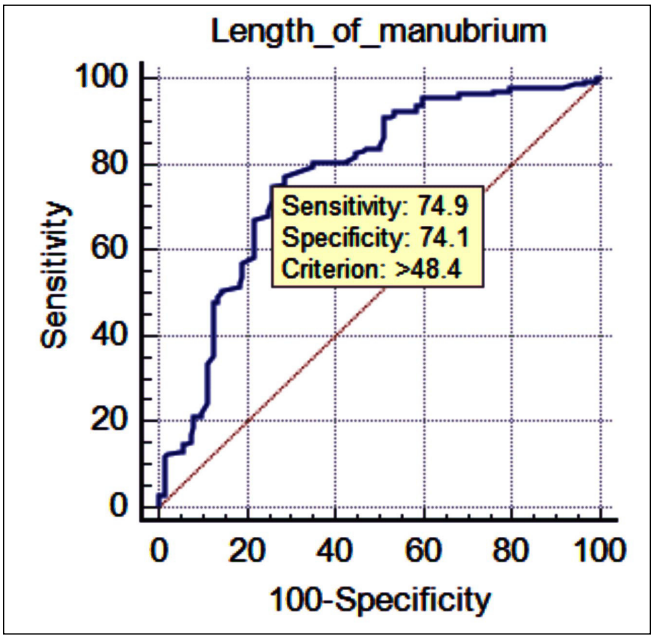

Figure 2: ROC Curve [Length of Manubrium]

Variable	Length_of_manubrium
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	0.771
Standard Error[a]	0.0194
95% Confidence interval[b]	0.736 to 0.803
Z statistic	13.992
Significance level *P* (Area=0.5)	<0.0001
Youden index	
Youden index *J*	0.4897
Associated criterion	>48.4
Sensitivity	74.86
Specificity	74.11

The above Table 3 is the ROC curve for the length of manubrium. The length of manubrium is able to correctly identify the gender in 74.86% (Sensitivity) while it was able to correctly negate the gender in 74.11% (specificity). Though, this variable is having a good sensitivity and specificity, but 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). The cut-off value of length of manubrium is 48.4, i.e., if the length of manubrium is >48.4, then it is a male, else it is a female.

DISCUSSION

The observations of various authors regarding the sexual dimorphism in length of manubrium, length of mesosternum and combined length are presented in the above Table 3.

Length of Manubrium

In the present study, mean length of manubrium in male and female sterna is 51.21 mm and 46.93 mm, respectively, in accordance with the observations[9-10].

The difference in mean length of manubrium of male and female sterna is 4.28 mm, which is statistically highly significant ($P<0.05$), showing a longer length of manubrium in the males in comparison to females and in accordance with the value of Dwight *et al.*[12] (1881), Adhvaryu Ankit *et al*. (2013), Gautam *et al*. (2003) and Dahipale *et al*. (2002).

Table 3: Showing comparison of length of sternum (Mean, Regression value, difference in mean) done by various authors

Name of author	Specimen		Manubrium (M) in mm		
	Sex	No.	Mean	Regression equation value	Difference
Dwight *et al.* (1881)	M	30	51.8	1.65	5.1
	F	26	46.7	1.45	
Dwight *et al.* (1890)	M	142	53.7	1.73	4.3
	F	86	49.4	1.55	
Paterson (1904)	M	310	52	1.66	4.7
	F	126	47.3	1.47	
Ashley (1956), African	M	85	45.9	1.41	1.7
	F	13	44.2	1.34	
Ashley (1956), European	M	378	52.2	1.67	4.3
	F	168	47.9	1.49	
Jit *et al*. (1980), North India	M	312	51.73	1.65	3.3
	F	88	48.42	1.51	
Mahajan *et al*. (2009)	M	98	57.86	1.89	10.90
	F	55	46.96	1.46	
Gautam *et al.* (2003), Ahmedabad	M	56	53.00	1.70	5.00
	F	44	48.00	1.50	
Dahipale *et al*. (2002), Maharashtra	M	96	48.42	1.51	4.64
	F	47	43.78	1.33	
Puttabanthi *et al*. (2012), Andra Pradesh	M	57	47.48	1.48	25.80
	F	22	21.68	0.44	
Adhvaryu Ankit *et al*. (2013), Saurashtra region	M	45	48.95	1.50	4.92
	F	55	44.03	1.34	
Present Study (2017)	M	350	51.21	1.63	4.28
	F	282	46.93	1.45	

Mean value of length of manubrium from different observers of male having more than the present study is Dwight (1890), Paterson (1904), Ashley[13] (1956), Jit *et al*.[14] (1980), Mahajan *et al.* (2009), Gautam *et al*. (2003) and female having more value is Dwight (1890), Paterson (1904), Ashley (1956) European and Gautam *et al*. (2003).

Mean value of length of manubrium from different observer is similar in both male and female having less than present study, i.e., Adhvaryu *et al*.(2013), Puttabanthi *et al*. (2012), Dahipale *et al*. (2002) and Ashley (1956) African.

Regression analysis shown in the present study of manubrium is 1.63 and 1.45 mm in male and female, respectively, which shows that if value is more than 1.5 (near 02) then it is male and if less than 1.5 (near 01), then it is female, on applying regression formula of the present study on mean length of manubrium of different observer shows that Dwight (1881), Paterson (1904), Ashley (1956) European, Mahajan *et al*. (2009), Dahipale *et al*. (2002), Puttabanthi *et al*. (2012), Adhvaryu Ankit *et al*. (2013) are consistent with the present study, Gautam *et al*. (2003) is partially consistent with the present study.

CONCLUSION

For Sex:- The mean length of manubrium in relation to gender shows that in the female the mean length of manubrium was 46.93 ± 4.77 mm, while in the male it was 51.21 ± 4.79 mm. The difference was found to be **statistically significant (*P*<0.05)**, showing a longer length of manubrium in the males in comparison to the females.

The **discriminant analysis** in finding out the gender based on the length of the manubrium (M) in mm shows correct identification was 78% in females and 67.4% in males, hence, overall accuracy was 72.2% and its regression analysis chart was found to be **statistically significant (*P*<0.05)** 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, while its **ROC curve** correctly identify the gender in 74.86% **(Sensitivity)** while it was able to correctly negate the gender in 74.11% **(specificity)** and resulted that **the cut-off** value of length of manubrium is 48.4 mm, i.e., if the length of manubrium is > 48.4 mm, then it is a male, else it is a female.

SUMMARY

Following summary was drawn based on the present study

(1) Manubrium

- The mean length of manubrium in relation to gender shows that in the female the mean length of manubrium was 46.93 ± 4.77 mm, while in the male it was 51.21 ± 4.79 mm.
- The difference was found to be statistically significant (*P*<0.05), showing a longer length of manubrium in the males in comparison to the females.
- The cut-off value of length of manubrium was calculated and observed 48.4 mm, i.e., if the length of manubrium is >48.4 mm, then it was a male, else it was a female.
- Regression equation formula for gender identification from length of manubrium was derived as:-

Gender = -0.422+0.04009 length of manubrium (M) in mm.

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

Source of funding:- Self

Conflict of interest:- Nil

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