

Original Paper

Determination of Sex from Sternal Bone In Central Delhi Population

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Abstract

Identification of deceased is an essential part of post-mortem examination. A number of parameters are used for identification however the determination of sex is statistically the most important criteria. It immediately excludes almost half the population, in comparison to age, stature and race which provide wide number of variables. There have been a number of studies regarding sexing of the sternal bone throughout the world but the studies in India especially Delhi, the capital city of India are virtually non-existent. The present study was an attempt to determine the sternal parameters that can be used to identify the sex of an individual, where sternal bone is available.

Length of the manubrium was found to be the most reliable criteria of determining sex from sternal bone. Other parameters i.e. Length of mesosternum, Combined length of manubrium and mesosternum, Breadth of first sternebra at its waist, Breadth of third sternebra at its waist, Manubrio-corpus index and Relative width index of first and third sternebrae were not found to be useful. The use of multivariate analysis technique was found to increase the probability of determining the sex of individual by sternum.

Key Words: Length, Sternum, Mesosternum, Sex, Individual

Introduction:

Identification is recognition of an individual by means of various physical features and biological parameters, which are unique to each individual. Since the bone resists putrefaction and destruction by animals, they can be used for identification and can lead to a reliable determination of age, sex, race [1], stature of the individual. The determination of sex is statistically the most important criteria as it immediately excludes almost half the population, in comparison to age, stature and race which provide wide number of variables. [2]

Where the entire skeleton or skull or pelvis is available, identification of sex can be done with reasonable degree of certainty. However, when a single bone is presented for examination, it becomes difficult to determine the sex of the individual accurately.

Though, many studies are available using a number of long bones, the data related to sternum in the determination of sex is very limited in Indian population. Determination of sex from human skeletal remains is an essential element of any medico-legal investigation.

This work has been done in an attempt to obtain certain parameters by which the subsequent distinction of sex of individual is possible in event of such a requirement. Since the study is conducted in Delhi the subjects selected were only from Central Delhi as the race and built may affect the dimensions of the sternum.

Materials and Methods:

The present study was conducted in the Department of Forensic Medicine, Maulana Azad Medical College, Delhi during the years 2007-2009. 100 cases of both sexes were taken between the age group of 25 – 85 yrs.

The sex of the individuals was noted. The sternum were dissected out and buried in the soil for 6-8 weeks. Subsequently the following measurements were taken from it:

- Length of the manubrium (M), Length of mesosternum (B), Combined length of manubrium and mesosternum = M + B,
- Breadth of first sternebra at its waist = S₁, Breadth of third sternebra at its waist = S

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- Manubrio-carpus index (I_1) = $M/B \times 100$,
Relative width index of first and third sternbrae (I_2) = $S_1/S_3 \times 100$.

Subsequently the data obtained was analyzed using various statistical methods like measurement of mean, the difference of means, standard deviation, independent t test, discriminant functions and Pearson's coefficient for correlation.

Observations and Result:

In our study the mean lengths of the manubrium were 40.639 mm and 37.286 mm for males and females respectively. The level of significance of the difference between the means was statistically significant ($p < 0.000$) for the length of the manubrium. (Table 1)

The t test for equality of the means gave a value of 6.819 with statistically significant p value (< 0.000). The length of Manubrium can be considered to be a reliable parameter for the determination of sex from sternum.

The maximum length in case of females was 40.44 mm and the minimum length of the manubrium in case of males was 36.56 mm.

Hence it can be concluded from this study that if the length of the manubrium is less than 36 mm it is of a female and if the length is more than 41 mm then it is of males in the population of central Delhi.

In spite of the statistically significant p value (< 0.003) (Table 1) the length of mesosternum cannot be considered to be a reliable criteria for sexing of sternum due to the high percentage of overlapping cases of males and females. (Table 2) (Fig.2)

As a result of the excessive overlapping of the specimens of male and female sterna (Table 2), in spite of the significant p value (Table 1) the combined length of manubrium and mesosternum cannot be considered a reliable parameter in determining sex of the sternum. (Fig. 3)

Our study showed considerable overlapping between the Sternal index in male and female cases (table 2) and the absence of significant p value (table 1), so the Sternal index could not be considered as a reliable parameter for determination of sex from the Sternal bone in the central Delhi population. (Fig. 4)

There was a high degree of overlapping present between the male and female sternal bones (Table 2) due to which the breadth of the first sternbrae was not found to be reliable criteria for determining sex from sternum in spite of having a statistically significant p value. (Table 1)

It was deduced from the observations that the width of third sternbrae could not be considered a reliable parameter for sterna sex determination due to the high overlapping zone though the p value was significant. (Fig. 6)

The relative width of the first and the third sternal vertebrae was not considered a reliable parameter for sexing of sternum due to the insignificant p value and the high degree of overlapping. (Fig. 7)

A multivariate linear discriminant analysis technique was applied to the data and discriminant functions were generated. Based on this discriminant function the probabilities of classification in different groups were calculated and based on those probabilities the individual was assigned to their respective groups.

It was found that through the discriminant analysis technique 89.4% male and 58.8% female could be sexed correctly. (Table 3)

Discussion:

In the present study it is found that the length of manubrium is reliable for sexing the sternal specimens in central Delhi population. These findings are not in accordance with the works of Ashley, Jit et al and Dahiphale et al which showed that manubrium cannot be considered to be a reliable parameter for the sexing of sternum. [5-7]

The length of the mesosternum and the combined length of the manubrium and mesosternum were not found useful parameters in the present study. This is however not in concordance with the study of Ashley, Jit et al and Dahiphale et al, [5-7] which deduced that these parameters were useful in sexing the sternum. That the sternal index, the breadth of the first sternal vertebra, the breadth of the third sternal vertebra are not useful parameters for sexing the sternum is in accordance with the studies of other authors. [5-7]

The relative width index of the first and third sternal vertebra was not found useful as a determinant for sexing the sternum. This is corresponding with the findings of the other author's studies. [5]

Jit et al and Dahiphale et al [6, 7] applied the discriminant function to increase the accuracy of sex determination of sternum. Jit et al found that 89% male and 82% female sterna could be sexed correctly and Dahiphale et al found that 92% male and 87% female sternum can be sexed correctly using discriminant functions (Multivariate Analysis). [6, 7]

In the present study also, the discriminant function were generated, with prior

probability considered equal (that is male = 0.50 and female = 0.50). It was found that by using discriminant functions 89.4 % male and 58.8 % female can be sexed correctly.

Conclusion:

The present study showed that length of Manubrium is the only reliable parameter in sexing the sternal bone. Use of multivariate analysis technique by generating discriminant functions can further increase the possibility of identifying the sex of individual by sternum. However, further studies are required over larger population to ascertain the reliability of sexing criteria.

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Table 2: Cases Falling In Overlapping Zone

Parameters	Sex	Cases	Cases in Overlapping Zone (%)
Length of the manubrium(X)	M	66	35(53.03)
	F	34	22(64.7)
Length of the mesosternum(Y)	M	66	53(80.3)
	F	34	33(97.05)
Combined length (X+Y)	M	66	62(93.93)
	F	34	33(97.05)
Manubrium- Corpus Index (X/Y* 100)	M	66	66(100)
	F	34	33(97.05)
Breadth of first sternebrae	M	66	53(80.3)
	F	34	32(94.11)
Breadth of third sternebrae	M	66	61(92.42)
	F	34	31(91.17)
Relative width S1/S3*100	M	66	64(94.96)
	F	34	33(97.05)

Table 3: Discriminate Analysis for Sex Identification

	Sexed correctly	Sexed Incorrectly
Males	59 (89.4%)	7 (10.6%)
Females	20 (58.8%)	14 (41.2%)

Fig. 1: Length of the Manubrium

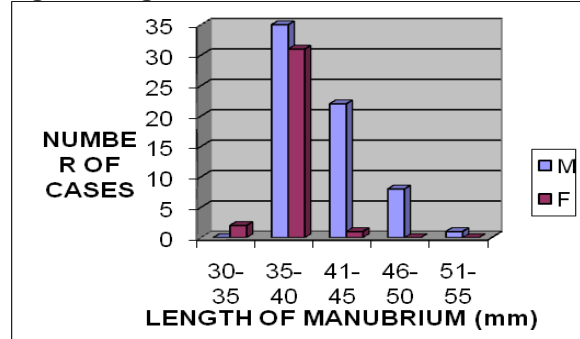


Fig. 2: Length of the Mesosternum

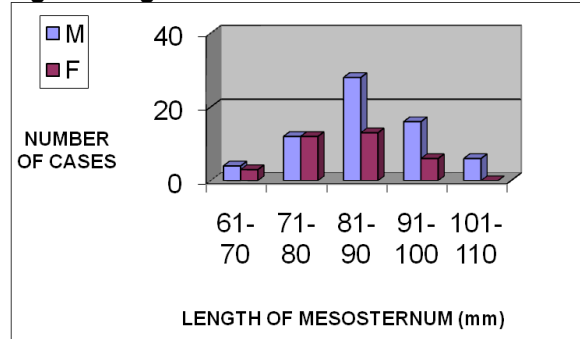


Fig. 3: Combined length of Manubrium and Mesosternum

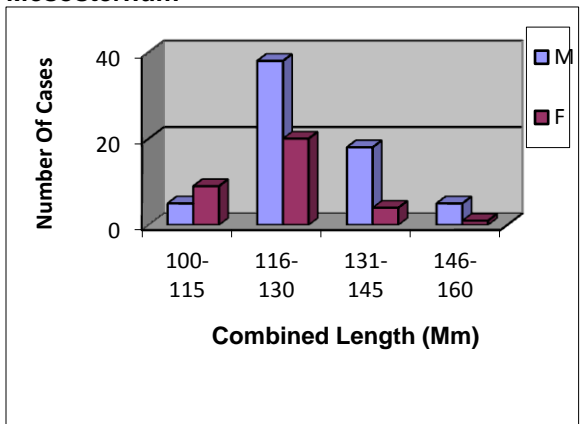


Fig 4: Sternal index

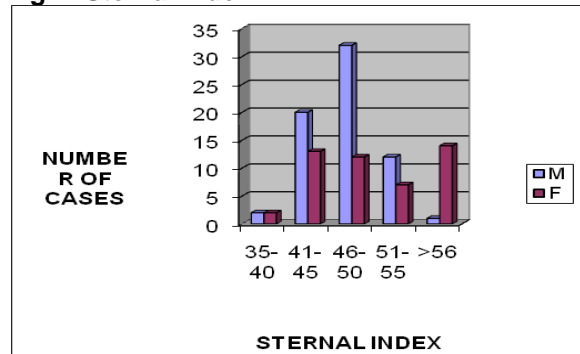


Fig. 5: Breadth of First Sternal Vertebrae

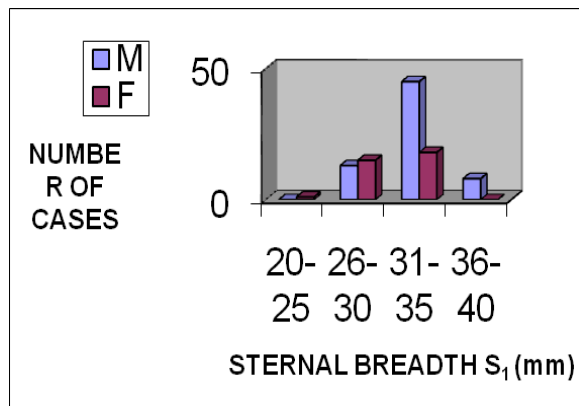


Fig 6: Breadth of Third Sternal Vertebrae

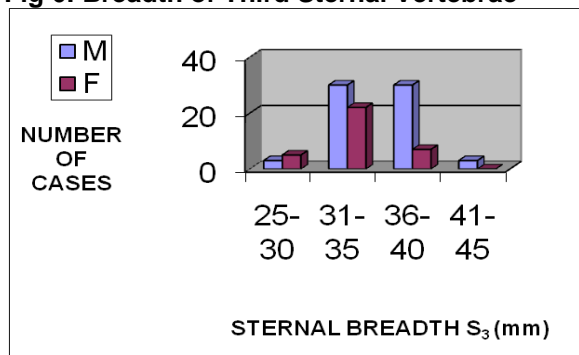


Fig 7: Relative Width Index of First and Third Sternebrae

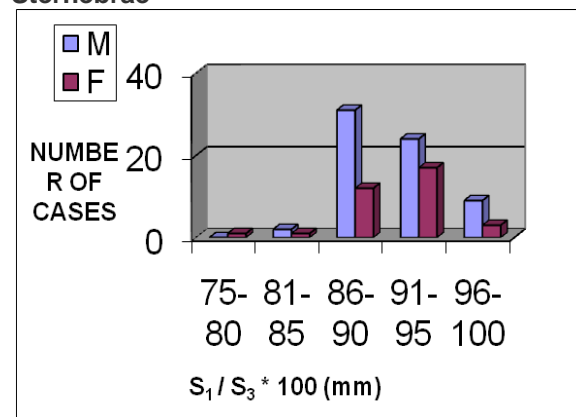


Table 1

Measurements of the Sternum in Both Sexes

Parameters	Sex	Range (Mm)	Mean (Mm)	S.D.	Level of Significance For The Difference Between The Means
Length of the manubrium(X)	M	36-52	40.639	3.47	P<0.000
	F	34-41	37.386	1.41	
Length of the mesosternum(Y)	M	66-107	87.31	9.51	P<0.003
	F	65-97	81.57	8.13	
Combined length (X+Y)	M	104-157	127.95	12.12	P<0.002
	F	100-150	120.09	9.99	
Manubrium- Corpus Index(X/Y* 100)	M	39-55	46.809	3.73	P<0.477
	F	37-56	46.181	4.35	
Breadth of the first sternebrae	M	26-39	31.767	2.39	P<0.001
	F	24-34	29.99	2.22	
Breadth of the third sternebrae	M	29-43	35.165	2.80	P<0.001
	F	28-39	33.163	2.74	
Relative width S1/S3*100	M	83-99	90.44	3.53	P<0.877
	F	79-98	90.56	3.62	

Table 4

Gender Differences Recorded By Various Workers

		Strauch (1881)	Dwight (1881) ³	Dwight (1890) ⁴	Ashley (1956) ⁵ (European)	Ashley (1956) ⁵ (African)	Jit (1986) ⁶	Dahiphal (2002) ⁷	Gautam (2003) ⁸	Present Study
Length Of The Manubrium(X)	M	-	51.8	53.7	52.2	45.9	51.73	48.458	53	40.639
	F	-	46.7	49.4	47.9	44.2	48.42	43.781	48	37.386
Length Of The Mesosternum(Y)	M	110	105.9	110.4	104.7	96.5	95.35	94.427	95	87.31
	F	90	89.4	91.9	90.8	82.9	78.6	70.191	76	81.57
Combined Length (X+Y)	M	-	-	164.1	156.9	142.6	147.08	142.196	149	127.95
	F	-	-	141.3	138.7	127.1	127.02	113.172	124	120.09
Breadth Of First Sternebrae	M	-	-	-	-	-	27.45	27.166	21-62	31.767
	F	-	-	-	-	-	24.32	24.44	24-51	29.99
Breadth Of Third Sternebrae	M	-	-	-	-	-	32.58	31.947	-	35.165
	F	-	-	-	-	-	29.19	28.236	-	33.163