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## A Macroscopic Study: Sex Determination from Sternal end of Fourth Rib in Western Rajasthan Population

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**ABSTRACT** - Many areas of the skeleton have been researched in regards to sex because estimation of sex is extremely important for the biological profile of an individual. Although the pelvis, long bones, and skull have been shown to provide accurate estimates of sex, there are numerous occasions where these elements are not recovered or small segments are available then it is very difficult to identify the sex. The present study showed the sternal extremity of the fourth rib can be used in determining the sex by direct metrical analysis of an isolated 4th rib. The samples (67 males, 33 females) were obtained from individual of known age and sex and three measurements (SIH, APB and MPD) were taken from each rib. It is apparent from this study that the method of measuring height and breadth of the sternal end of the fourth rib can produce highly significant association when assessing sex. It was therefore concluded that sexual dimorphism can be detected by direct measurement of fourth rib.

**Keywords:** *Fourth Rib, Sex Determination, Microscopic Study.*

### I. INTRODUCTION

Positive identification involves matching of an “unknown” individual to a “known” individual. The identification of skeletal and other decomposed human remains is very important for legal and humanitarian reasons. Moreover, sex determination is the main objective. Basing sex determination on the shape of skeletal features can lead to divergent opinions according to individual experiences. Thus, an impartial metric method for sex determination is essential.

A number of bones have been studied in attempts to establish methods of sex determination based on examination of bones. The pelvis and skull have been the most reliable giving accuracies of determination of 95 and 90% for adult material.<sup>37</sup> Other bones result in varying degrees of reliability. Determination of sex from skeletal remains has been studied and analyzed extensively by researchers from abroad. In India the pioneers in this field are Jit & Singh<sup>1</sup>, Krogman<sup>2</sup> view that 100 % accuracy in

sex determination can be achieved when the entire skeleton is available. However problem arises when fragmentary remains of skeleton are brought for examination.

Therefore we have used the sternal end of 4th ribs to establish the identity of sex of the victim. There have been very few studies on the determination of sex from the rib. Most of these studies were based on radiological examination of the entire anterior thorax focusing on the pattern of calcification of the costal cartilages. In the process of developing standards for age determination from the rib, Iscan et al. observed that age-related changes were sexually dimorphic<sup>3,4,5</sup> and this led to the development of separate standards for males and females.

## **II. AIMS AND OBJECTIVES:**

The aim of this study is to assess the applicability of using sternal end of fourth rib for sex estimation.

## **III. MATERIAL AND METHODS**

The present study was conducted in Anatomy department & department of forensic medicine of S. P. Medical College & associated hospitals, Bikaner, Rajasthan. 102 samples of 4<sup>th</sup> rib taken of both sexes from dead body brought for postmortem examination in mortuary after taking consent from the kin of the deceased. Out of these 100 samples of 4<sup>th</sup> rib of right side (to keep uniformity) were taken for study and 2 were excluded because they were partially destroyed and fractured during collection procedure and were not suitable for study.

As soon as the body was brought for post-mortem examination its particulars were recorded and age was cross checked from relatives. The sternal extremity of 4th rib was chosen because it fairly represents true rib and can be easily extracted during a postmortem examination. The samples consisted of individuals above 15 years of age, as morphological metamorphosis at the sternal end of the rib is not observed until this age. The samples were selected of no pathological disorder & died from natural cause & not affected by any disease which can alter individual's skeleton.

The specimens were separated from the body by cutting fourth rib at two points i.e. three centimeter inner to and five centimeter outer to costochondral junction using a rib cutter without damaging the costochondral junction

The muscles attached to the ribs were cut using scissors. The portion of ribs were labeled and kept in water containers for three to four weeks. Thus the soft tissues could be removed from the bone easily. The remaining soft tissue and cartilages if any were removed by keeping the bones in boiling water for ten to fifteen minutes. Bones were thoroughly dried at room temperature and each rib was examined meticulously to ascertain the stage of morphological change.

All measurements were taken in accordance with the procedure described by Iscan and associates.<sup>6</sup> although not given in precise detail, Iscan et al.<sup>6</sup> took the SIH and APB measurements at the costochondral junction of each rib, the method followed by the present study. The costochondral junction is defined as the junction of the rib into cartilage in the anterior chest. All of the measurements were taken with a sliding caliper calibrated to the nearest 0.1 mm. These measurements are defined as:

- Maximum Superior Inferior Height (SIH): the maximum distance between the most superior and inferior points at the end of the rib.
- Maximum Anterior Posterior Breadth (APB): the maximum distance between the most anterior and posterior points at the end of the bone.
- Maximum Pit Depth (MPD): Maximum Pit depth is one of the most obvious age related changes observed in sternal end of the rib. The maximum depth of this pit was measured with a depth caliper calibrated to 0.1 mm by keeping the caliper perpendicular to base of the pit.



**Fig: 1** Superior-inferior height (SIH) measurement



**Fig: 2** Anterior-posterior breadth (APB) measurements

After calculating the above measurements the z test applied on above values for estimation of its significance.

#### IV. OBSERVATIONS & RESULTS

In present study total 100 cases were examined (table 1) & they are distributed in 4 major groups. Out of 100 cases males constituted 67 while females constituted 33 of the samples denoted in table 2.

**Table 1: Age distribution of study sample (N = number of individuals)**

<b>AGE RANGE</b>	<b>Groups coding</b>	<b>N</b>	<b>% distribution</b>
15-30	1	55	55
31-45	2	27	27
46-60	3	17	17
<60	4	01	1
<b>TOTAL</b>	<b>4</b>	<b>100</b>	<b>100</b>

**Table 2: Sex distribution of study sample (N = number of individuals)**

<b>S. No.</b>	<b>AGE RANGE</b>	<b>MALE</b>		<b>FEMALE</b>		<b>N (sexes pooled)</b>
		<b>N</b>	<b>% DISTRI-BUTION</b>	<b>N</b>	<b>% DISTRI-BUTION</b>	
1	15-30	33	60	22	40	55
2	31-45	19	70	08	30	27
3	46-60	15	88	02	12	17
4	<60	00	00	01	100	01
	<b>TOTAL</b>	<b>67</b>	<b>67</b>	<b>33</b>	<b>33</b>	<b>100</b>

**Table 3: Descriptive statistics among sexes (N = number of individuals)**

<b>S.No.</b>	<b>SEX</b>	<b>N</b>	<b>MEAN (years)</b>	<b>SD (years)</b>
1	M	67	34.38	12.46
2	F	33	29.36	11.75
3	TOTAL	100	32.73	12.40

The ages of the individual are shown in Master chart. The age of all sample ranged between 15 and 62 years with a mean age of 32.73 years. The age range for males was between 15 to 60 years (mean age=34.38 years), while the females range was between 18 to 62 years (mean age=29.36 years) shown in table 3. It is clearly visible from table 2 that individuals from each decade were included.

Sternal end of fourth rib was used to measure following three parameter in all samples male & Female:-

- Maximum Superior Inferior Height (SIH) : the maximum distance between the most superior and inferior points at the end of the rib
- Maximum Anterior Posterior Breadth (APB): the maximum distance between the most anterior and posterior points at the end of the bone
- Maximum Pit Depth (MPD): Maximum Pit depth is one of the most obvious age related changes observed in sternal end of the rib. The maximum depth of this pit was measured with a depth caliper calibrated to 0.1 mm by keeping the caliper perpendicular to base of the pit.

Descriptive statistics for each measurement are found in Tables 4. Table 4 is broken down specifically by the variable, and it also separated the data further into males and females. The number of individuals reported in Tables 4 and 5 reflects all individuals in the study sample, mostly referring to the right-side rib. The stepwise selection method did not remove any measurements for the purpose of discrimination; therefore all variables were run in the DFA.

Descriptive statistics of all the cases with their individual parameter of the rib measurement showed that if individual's age is not less than 15 years then all the three parameters can be used to separate the sex, as morphological metamorphosis at the sternal end of the rib is not observed until this age. (table 4)

**Table 4 – Descriptive statistics of parameters**

	No. of cases	SIH		APB		MPD	
		Mean	SD	Mean	SD	Mean	SD
<b>Male</b>	67	1.494	0.161	0.482	0.104	0.194	0.073
<b>Female</b>	33	1.145	0.170	0.369	0.116	0.151	0.065

(All the values except no. of cases are in centimeters (cm).)

According to the test all the three parameters used for sex determination are fit for all age group (if individual age is more than 15 years) as their significance value is <0.005. (table 5)

**Table 5- Distribution of study samples according to their SIH, APB, MPD (in cms) & their sex.**

Parameters	SEX	MEAN	Z test	P value
SIH	M	1.494	10.00	0.0001
	F	1.145		
APB	M	0.482	4.91	0.0001
	F	0.369		
MPD	M	0.194	2.86	0.005
	F	0.151		

It is observed from the above table 5 that all the three parameters can appropriately and positively discriminate the gender. All the three parameters have shown highly significance.

One must however interpret this cautiously because of inter correlation between the predictor variables. The structure coefficient shows the pooled within group correlations between the predictor variables and the discriminant function. This coefficient controls the possibility of inter correlation.

It is apparent from this study that the method of measuring height and breadth of the sternal end of the fourth rib can produce highly significant association when assessing sex.

## V. DISCUSSION

There have been very few studies on the determination of sex from the rib. Most of these studies were based on radiological examination of the entire anterior thorax focusing on the pattern of calcification of the costal cartilages.

Iscan<sup>6</sup> showed that accuracy of sex determination from the right 4th sternal rib ranged from 80% for young males less than 30 years to as high as 89% for males 30 years and above with accuracy for females of both age groups in between the two values. The percentage of cases classified correctly is often taken as an index of the effectiveness of the discriminant function.

The goals of this study were to determine if the sternal end of fourth rib is useful for estimating sex in a forensic context.

This study has demonstrated that 4th rib shows sexual dimorphism It is observed that all the can appropriately and positively discriminate the gender. All the three parameters have shown highly significance. It is apparent from this study that the method of measuring height and breadth of the sternal end of the fourth rib can produce highly significant association when assessing sex.

The similar study was done on Turkish population which also showed that SI height is most reliable dimension for sexual dimorphism and if both dimensions are taken together it gives an accuracy of 86 % to 90%.<sup>7</sup>

Similar study done on West African population in Ghana showed the accuracy of sex determination varied from 80% in the young and 74% in the old groups to 78% for the total group.<sup>8</sup> Iscan et al<sup>6</sup> study in North American whites and black as well as in others showed the accuracy of sex determination varied from 82% in the young and 89% in the old group to 83 % for the combined group. The study is based on known age of males and females so the assessment of age is very much important before the analysis of the gender. If the approximate age is not known then there can be error in determination of gender. It should be noted that in all the studies mentioned above, 4th rib is used for the assessment.

So still in the field of Forensic Medicine, we remain handicapped to exactly pinpoint the accuracy from one single factor, as metamorphic changes in the sternal end of the 4th rib alone are not sufficient to assess the accurate sex of a subject.

## VI. CONCLUSION

The present research shows that several variables are important for the estimation of sex from the sternal end of the fourth rib. When using the rib APB and SIH measurements together, significant results were also obtained, which are better than individual parameters. All the parameters show positive significance which explained that sternal end of fourth rib is also reliable for sex determination. This study is a positive first step for estimating sex in forensic settings on recent Western Rajasthan Population based on the sternal ends of the fourth rib. Also, the percent classified correctly is comparable to reliable bones such as the femoral head, tibia, and skull.

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