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Study of sexual dimorphism in human sacrum - in North Karnataka

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ABSTRACT

Objectives: This study was under taken to know the sexual differences in an adult (north Karnataka) human sacrum & thus identify a male from a female sacrum using various parameters. **Materials & Methods:** 254 dried completely ossified grossly normal human adult sacrum of both sex (190 male & 64 female) is taken from anatomy department of Mahadevappa Rampure Medical College, Gulbarga. **Results:** In the study the male sacrum showed significantly higher values for i) ventral straight length, ii) ventral curved length, iii) maximum sacral width (breadth of S1), iv) minimum width of sacrum & v) Weight, than female sacrum, while the female sacral index showed higher values when compared with that of male. Identification point & demarking point (DP) helped in sexing the sacrum with certainity. The most useful index for sex determination of sacrum in this study was sacral index.

Summary & conclusion: after a detailed study & comparison of my work with others, I conclude that demarking point & identification point helped in sexing the sacrum with certainty. The most useful parameter in my study was sacral index. Continued study over a period of time in a defined area will definitely help in establishing the anthropometric standards for sexing the sacrum.

Key word : Sacrum, sexual dimorphism, parameters, sacral index.

INTRODUCTION

The bones of the body are the last to perish after death, next to the enamel of teeth. Hence, in establishing the personal identity with respect to sex, age & stature, medico legal experts, anatomist & anthropologist use the skeletal materials for giving their opinion. The exact establishment of identity of sex depends on the number of bones sent for examination. It was observed by Taylor [1] in his book of medical jurisprudence that the accuracy of estimating the sex from skeletal remains depends upon number of bone available-

*Skull +femur =97.35%

*Coccyx +sacrum =97.18%

*Pelvis =95%

*Skull alone =91.38%

*Femur =39.84%

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· Atlas vertebra= 31.18%

Krogman[2] made an estimate to decrease the above figures by 5-10%. Taylor[1] & Krogman[2] thus showed the statistical analysis, while the Stanfield's[3] postulation of evolutionary biology says that the genotypic variance is inversely proportional to the intensity of stabilizing the selection. This will explain the difference in the morphology of adult human males & females. Morphological features over the bones also depend on the nutritional, geographic & occupational factors .Till now various workers have quoted that skull & pelvis are of much help in determining the sex of the skeletal material. How ever it is observed that no much work is done over the bone "sacrum". Hence, the present work is an attempt to establish some parameters which will be of great help in sex identification, both in anthropometric & medicolegal study, of a defined area over a period of time.

MATERIALS & METHODS

The study was conducted in the department of Anatomy Mahadevappa Rampure Medical College, Gulbarga (North Karnataka). 254 sacra of both sexes (190 male & 64 female) were examined to complete the present study.

All the sacra used for the study were completely ossified & had no deformity.

From each sacrum following metrical data is recorded as in the manner described below:

1. Ventral straight length: with the help of sliding vernier caliper maximum straight length was measured in centimeters up to first decimal on the ventral side of the sacrum, as shown in figure – 1.

2. Sacral midventral curved length: the ventral concave median length in centimeters from midpoint of promontory to the midpoint of apex of the sacrum was measured by using the flexible ribbon tape as shown in figure - 2.

3. Maximum sacral width (anterior straight breadth at the level of S1): with the help of sliding vernier calipers maximum distance was noted between the midpoint of left & right alae of sacrum as shown in figure - 3.

4. Minimum sacral width: with the help of vernier calipers, the minimum distance was measured at the apex of the sacrum in cms as shown in figure – 4.

5. Weight of the sacrum: each sacrum was weighed on the scientific balance, weight recorded in grams up to first decimal point.

$$\text{Sacral index} = \frac{\text{Sacral width (width of S1)}}{\text{Sacral ventral straight length}} \times 100$$

Following formulae are used for calculating the values,

$$1.\ \text{Mean}\ (\bar{X}) = \frac{\text{Sum of all the values}}{\text{No. of values}}$$

$$2.\ SD = \sqrt{\Sigma \frac{(X-\bar{X})^2}{(N-1)}}$$

3. Range = Mean ± 3 SD

RESULTS

From the obtained values, demarking points (DP) is calculated on the lines of Jit & Singh[4] & the percentage of the bones, thus identified were found out in relation to each parameter.

Thus, the demarking points for ventral straight length of sacrum for males is >12cms & of females is <8.58. This would cover 99.75% of the samples & help in fixing the sex of an unknown sacrum with reasonable accuracy.

Similarly all the parameters were analyzed to arrive at the demarking points, & percentages of identified bones were recorded. Identification point (IP) is a limiting point of actual range of every measurable parameter in male & female.

The recordings of these detailed measurements are shown in table 1 & 2.

DISCUSSION

Taking into account, the various parameters of the sacrum, the merits & demerits of each measurement such as mean, it's definitive value for male & female, statistical significance were compared with other workers. Accordingly, in sexual dimorphism of human bones, Davivong's[5] has stated that as a general rule, the male bones are more massive & heavier than female bone. This rule also governs the size & articular surfaces as well. In his article on Australian aboriginal pelvis, has stated "sex determination by sacrum alone is never satisfactory, overlap of the male & female ranges is very extensive in every measurement of the bone.

Flanders[6] in also suggests that larger sample size is required in multivariate techniques & this method is more useful in sexing the long bones. But similar problem of overlap in male & female ranges in various parameters was awfully noticed. Similar difficulties were observed in the work of Hardlicka[7] & Raju et al[8] The reason for the overlap could be due to:

Considerable frequency of hypo masculinity in male bones or hyper feminity in female bones.

The above factor may be related to genetic, nutritional, socioeconomic & physical stress in the individual. The degree of overlap can however be reduced if the range is derived on the basis of mean ± 3 SD which gives 99.75% confidence limit thereby ensuring the statistical validity. Thus if genetic & geographic factors are important factors, then we can safely presume that the standards laid down for a defined area after extensive & co-related studies will remain constant for a long period of time .However, if predominant influences are observed to be the plastic ones (nutritional, life style & physical stress), it is hypothesized that the anthropometric standards will have to be evaluated from time to time in the perspective of such influences for their validity.

In discussion of every parameters an attempt has be made in the present work to simultaneously compare with others study.

For 190 male & 64 female sacra studied, the mean value for the ventral straight length in male is 11.10 cms and that for female 9.45 cms. Sacrum with ventral straight length measuring above 11.0 cms is definitely male and below 8.2 cms is definitely a female.

48.82 % male and 7.08 % female sacra did not over lap.

Mean value for male bones is significantly higher than in female bones.

14.43 % male and 15.39 % female bones fall beyond demarking point.

Difference between the male and female mean is statistically highly significant.

Table – 3 shows comparison of ventral straight length in cm with others study .Our findings are nearly consistant with the finding of Bagde[9].

Average valves (mean) for ventral curved length in male (190) is 11.26 cm & that for female (64) is 10.2 cm sacrum with ventral curved length measuring above 11.7 cm is definitely a male & below 9.2 cm is definitely a female

29.12% male & 29.81 % female sacra did not over lap

Mean value for male sacra is significantly higher than in female sacra.

7.35% male & 7.21 % female sacra fall beyond demarking point.

Difference between male & female mean is statistically highly significant.

Table 3 shows comparison of ventral curved length in cm with others study. Our findings are nearly consistant with the findings of Davivongs[5].

Average value for maximum transverse length (width) in male (190) is 10.42 cm & that for female (64) is 10.63 cm sacrum with maximum width measuring above 12.1 cm is definitely a male & below 6.5 cm is definitely a female.

3.07 % of male & 0% female sacra did not over lap.

The male samples 0.57 % & 0% of female fall beyond demarking point.

The sex difference in mean values in maximum

width in male & female is not statistically significant.

Table 3 shows comparison of maximum width of sacrum in centimeters with others study. Our findings are nearly consistant with the findings Raju et al.[8]

Average value for sacral index in males (190) is 94.24 & that for females (64) is 113.19

None of the samples of male & female sacra overlap

Mean value of female is significantly higher than male.

0.53% of male & 0% of female sacra fall beyond demarking point.

Difference between male & female mean is statistically highly significant.

Table 3 shows the comparison of sacral index with others study. Our findings are nearly consistant with Raju et al[8].

CONCLUSION

After a detailed study of 254 sacra (190 male & 64 female) & comparing with other workers it can be concluded that: identification point & demarking point help in sexing the sacrum with certainity. The most useful index for sex determination of sacrum in our study is sacral index. Continuance of such studies in a defined area over a period of time will definitely help in establishing the anthropometric standards. Such studies will also be useful to observe the changing trends if any , in the metric measurements which may be influenced by the environmental socioeconomic factors , physical stress & genetic factors.

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Table 1: Shows the measurements of various parameters of male sacrum.

Sl. No	Parameter	Total no. Bones	Range	Mean	Standard Deviation	Statistical Significance	D.P	I P	Percentage Beyond D.P.	Percentage of Identified Bones
1	Ventral. Straight Length	64	7.8-11.11	9.45	0.85	Highly Significant	< 8.58	< 8.2	15.39 %	7.08 %
2	Ventral. Curved length	64	8.5-11.5	10.02	0.803	Highly Significant	< 8.84	< 9.6	7.21 %	29.8 %
3	Maximum Width of Sacrum.	64	9.2-12.1	10.63	0.691	Not Significant	< 7.72	< 6.5	0 %	0 %
4	Minimum. Width of sacrum	64	2.0-3.0	2.31	0.30	Highly Significant	< 1.35	< 2	0 %	15.15 %
5	Weight. in grams.	64	20.0-75	39.84	12.07	Highly Significant	< 18.55	< 35	3.92 %	34.4 %
6	Sacral index	64	91.89-146.15	113.19	10.26	Highly Significant	< 58.9	< 58.9	0 %	0 %

Table 2: Shows the measurements of various parameters of female sacrum

Sl. No	Parameter	Bones No	Range	Mean	Standard Deviation	Statistical Significance	D.P	I P	Percentage Beyond D.P.	Percentage Identified Bones
1	Ventral. Straight Length	64	7.8-11.11	9.45	0.85	Highly Significant	< 8.58	< 8.2	15.39 %	7.08 %
2	Ventral. Curved length	64	8.5-11.5	10.02	0.803	Highly Significant	< 8.84	< 9.6	7.21 %	29.8 %
3	Maximum Width of Sacrum.	64	9.2-12.1	10.63	0.691	Not Significant	< 7.72	< 6.5	0 %	0 %
4	Minimum. Width of sacrum	64	2.0-3.0	2.31	0.30	Highly Significant	< 1.35	< 2	0 %	15.15 %
5	Weight. in grams.	64	20.0-75	39.84	12.07	Highly Significant	< 18.55	< 35	3.92 %	34.4 %
6	Sacral index	64	91.89-146.15	113.19	10.26	Highly Significant	< 58.9	< 58.9	0 %	0 %

D.P -Demarking point **, I.P** –Identification point , **C.R** – Calculated range

Table 3: Shows the comparison between our study & various investigators

Sl. no	Parameters	Investigators	Male				Female				S.S.D
			N	X	R	S.D	N	X	R	S.D	P
1	Ventral straight length	Bagde{1981} Our study{2003}	65 190	10.21 11.0	8.7-11.2 8.2-13.3	0.571 0.84	30 64	8.85 9.45	7.7-10.2 8.2-11.1	0.648 0.85	<0.001 <0.001
2	Ventral curved length	Davivongs{1963} Our study {2003}	50 190	10.43 11.26	8.2-11.5 9.2-14.1	0.71 0.85	50 64	9.71 10.0	8.1-11.0 8.5-11.5	0.674 0.803	<0.001 <0.001
3	Maximum width	Raju et al {1980} Our study{2003}	117 190	10.47 10.42	8.6-12.0 6.5-14.2	0.65 0.90	83 64	10.3 10.6	8.5-11.7 9.2-12.1	0.654 0.691	N. S N.S
4	Sacral index	Raju et al {1980 } Our study{2003}	33 190	100.85 94.24	74.7-129 54.5-152	8.71 11.78	11 64	111.3 113.1	88.4-134 91.9-146	7.67 10.3	<0.001 <0.001

N- Sample size; x-mean, **S.D**-Standard deviation **;** **P**-Probability**,** **N.S** –Not significant; **S.S.D**-Statistically significant difference between the two sexes.

Figure 1: Shows Sacral Ventral straight length

Figure 2: Shows Sacral Midventral curved length.

Figure 3: Shows Maximum sacral width

Figure 4: Shows Minimum sacral width