A STUDY OF SACRAL INDEX: A BASIS FOR DETERMINATION OF SEX OF SACRUM

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ABSTRACT

Introduction: Sacrum is an important bone for identification of sex in human skeletal system, because the bones of the body are the lasts to perish after death, next to the enamel of teeth. For sex determination of human skeletal remains, sacrum always captured the attention of forensic science experts and anthropologists. Sex determination of a skeleton is a problem of concern to Paleoanthropologists, Paledemographers and Anatomists.

Materials and Methods: The present study was conducted on 100 fully ossified adult human sacra of known sex (50 male and 50 female), obtained from department of Anatomy, Mysore medical college and research institute, Mysore. Damaged, mutilated, deformed and anomalous sacra were excluded from the study. Sacral index was measured by measuring the length and breadth of individual sacrum with the help of sliding vernier callipers.

Observations and Results: The mean maximum length of the sacrum was greater in males (102.68 mm) than in females (91.11mm), and this difference was found statistically significant. But the difference was not significant for mean maximum sacral breadth in male (103.80 mm) and in female (105.57 mm). Mean sacral index in females was greater (116.18%) as compared to that in males (101.26%) and this difference was found statistically significant.

Conclusion: The present study showed a significant difference among the average male & female sacral indexes and considers sacral index as a valuable parameter in identification of sex. The male & female sacra are classified under (Dolichohieric & Hyplatyhieric) and Platyhieric group respectively. Hence, it can be concluded that sacral index is a reliable criterion for differentiation between sexes of sacrum that is useful for Anatomists, Anthropologists & Forensic experts.

KEY WORDS: Sacrum, Sacral Index, Sex Determination.

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INTRODUCTION

Sacrum is an important bone for identification of sex in human skeletal system, because the bones of the body are the lasts to perish after

death, next to the enamel of teeth. For sex determination of human skeletal remains, sacrum always captured the attention of forensic science experts and anthropologists[1]. Sex determination of a skeleton is a problem of

concern to paleoanthropologists, pale demographers and Anatomists.

Accuracy of sex identification based on the study by Krogman[2]: Entire skeleton is 100%, pelvis plus skull is 98%, pelvis alone 95%, skull alone 90% and long bones alone 80%. Most anatomists do not claim 100% accuracy even where skeleton is available.

The sacrum displaces metrical sexual differences. Female sacra are less curved, the curvature being most marked between the first and second segments and third and fifth, with an intervening flatter region. Male sacra are more evenly curved, relatively long and narrow and more often exceeding five segments. Average values of sacral index for male and female are 105% and 115% respectively[1].

The most important criteria for sex determination using sacrum are sacral index. There are wide variation exists between the male and female sacrum in different races and regions, and there is scarcity of data available. Thus the present study is carried out to determine the sex of sacrum using sacral index.

Objectives: To measure and record morphometry of sacrum under the following headings in order to study the sacral index which will be useful for determination of sex of sacrum.

1) Maximum length of sacrum. 2) Maximum breadth at base of sacrum. 3) Sacral index.

MATERIALS AND METHODS

Source of data: The present study was conducted on 100 fully ossified adult human sacra of known sex (50 male and 50 female), obtained from department of Anatomy, Mysore medical college and research institute, Mysore. Damaged, mutilated, deformed and anomalous sacra were excluded from the study. Sacral index was measured by measuring the length and breadth of individual sacrum with the help of sliding vernier callipers.

Study design: It is an observational study.

Type of analysis: It is a descriptive type of analysis.

Measurement of parameters

1) The length (fig-1) was measured between midpoints on the anterior margins of the prom-

ontory and apex.

2) The breadth (fig-2) was measured between most anterior points on the auricular surfaces.

3) Sacral index (compares sacral breadth with sacral length) = $\text{Maximum breadth} \times 100 / \text{Maximum length}$.

The readings were recorded, tabulated and subjected for statistical analysis.

Fig. 1: Measurement of Length of sacrum.

Fig 2: Measurement of Breadth of sacrum.

OBSERVATIONS AND RESULTS

The mean maximum length of the sacrum was greater in males (102.68 mm) than in females (91.11mm), and this difference was found statistically significant. But the difference was not significant for mean maximum sacral breadth in male (103.80 mm) and in female (105.57 mm). Mean sacral index in females was greater (116.18%) as compared to that in males (101.26%) and this difference was found statistically significant (Table-1).

In the present study, by calculating sacral index of sacrum, 42 (84%) males and 26 (52%) female sacrum were identified accurately.

Table 1: Measurements of sacrum in the present study.

Sl.no	Parameters	Sex	Range	Mean	SD	T-value	P-value
1	Length of sacrum (mm)	Male	89.93-120.13	102.68	6.8	8.65	<0.001
		Female	75.77-103.78	91.11	6.56		
2	Breadth of sacrum (mm)	Male	88.55-124.61	103.8	6.91	1.33	>0.05
		Female	92.03-118.45	105.57	6.35		
3	Sacral Index (%)	Male	81.23-109.61	101.26	6.04	11.03	<0.001
		Female	105.32-134.79	116.18	7.4		

Table 2: Comparative study of Sacral Index with previous studies.

Sl. no	Investigators	Male sacrum			Female sacrum		
		No	Mean SI	Range	No	Mean SI	Range
1	Singh et.al	26	94.32	76.3-110.94	12	104.81	95.77 -113.85
2	Dapate SS	117	94.58	77.27-118.42	83	104.27	85-136.36
3	Mishra SR et.al	74	98.21	90-108	42	117.84	103-131.25
4	Patel MM et.al	32	96.25	90.5-106	32	113.25	104.8-131
5	Shilaja	190	94.24	53.57-152	64	113.19	91.89-146.15
6	Raju PB et.al	33	100.85	74.72-126.9	11	111.39	88.38-134.4
7	Mazumdar S	127	94.9	80.5-109.3	123	109.8	87.9-131.7
8	Ravichandran	63	96.32	80.7-106.4	60	102.29	93.1-108.8
9	Poornima J et.al	81	104.08	81-136	64	115.72	85-146
10	Mamatha Het.al	25	115.92	-	25	125.2	-
11	Asthana S et.al	58	96.25	85-106	42	113.33	100-126
12	Present study	50	101.26	81.23-109.61	50	116.18	105.32-134.79

Table 3: Comparison of Sacral Index with other races & regions.

Sl. no	Authors	Race and Regions	No	Max-Length- male (mm)	Max-Length- female (mm)	Max-Breadth- male (mm)	Max-Breadth- female (mm)	Mean Sacral Index- male (%)	Mean Sacral Index- female (%)
1	Davivongs V	Australian aborigine	50	96.52	88.12	99.92	101.24	104.16	115.4
2	Flander	American White	50	110.2	109.64	116.42	117.62	106.49	108.59
3	Flander	American Black	50	105.5	99.98	111.14	111.36	106.49	112.85
4	Mishra SR et. al	Indians (Agra)	116	107.53	90.58	105.34	105.79	98.21	117.84
5	Patel MM et. al	Indians (Gujarat)	64	-	-	-	-	96.25	113.25
6	Kataria et.al	Indians (Rajasthan)	74	106.7	91.91	110.3	109.88	104.11	120.01
7	Bindra GS & Mohan A	Indians (Haryana)	60	106.85	90.89	108.24	106.87	101.3	117.56
8	Ravichandran et al	Indians (TN & AP)	123	-	-	-	-	96.32	102.92
9	Arora AK et. al	Indians (Punjab)	40	-	-	-	-	93.68	125.35
10	Present study	Indians (Karnataka)	100	120.13	103.78	124.61	118.45	101.26	116.18

Table 4: Classification of sacrum by Sacral Index.

Classification	Range of sacral Index (%)	No. of Male sacrum (50)	No. of Female sacrum (50)
Dolichohieric (narrow)	<99.9	12	-
Hyplatyhieric (medium)	100-105.6	29	3
Platyhieric (broad)	>106	9	47

DISCUSSION

Human sacrum is one of the important bones used for identification of gender. The sacrum has always attracted the attention of the medico-legal experts for establishing the sex, because

of its contribution to pelvic girdle and associated functional gender differences. Sex determination is necessary to make age, ancestry and stature estimations, as the sex's age differently, exhibit some degree of variation in ancestry related morphology and generally differ in height[3]. A comparison between the males and females showed that the mean length of the male sacra was found to be higher than that of the female sacra in the present study. The mean length (table-1) of the male sacra, in the present study is 102.68 mm, which is lower when

compared to that of Agra region (107.53 mm) studied by Mishra SR[4]. et al, and the Varanasi region (104.96 mm) studied by Raju PB[5] et al. The mean length of the female sacra 91.11 mm is also shorter when compared to Agra & Varanasi regions. Comas & Charles[6] reported a wide variation between the male and female in the Chinese, Negroes & Bushmen. Davivongs V[7] in his study of Australian aboriginal sacra has reported mean length of sacrum to be 96.52 mm & 88.12 mm in the male & female respectively, which is lower when compared to the present study. The mean breadth (Table-1) of the male sacra in the present study is 103.80 mm which is close to similar observation made by Mishra SR[4] et al in the Agra region (105.34 mm) & Raju PB[5] et al. in the Varanasi region (105.33mm) respectively. However, the mean breadth, in the present study in females showed a similar value (105.57 mm) than that of Agra (105.79 mm) & Varanasi regions (103 mm). In the Australian aboriginal females, the maximum breadth of sacrum was 101.24 mm, which is higher than that of males (99.92 mm) of the same race studied by Davivongs V[7]. Thus there exists a regional and racial difference in the length & breadth of the sacrum.

Based on the sacral index, Anthropologists have classified the sacra into the followings groups: 1) Dolichohieric (narrow sacrum with SI < 99.9), 2) Hyplatyhieric (medium sacrum with SI 100-105.9) & 3) Platyhieric (broad with SI >106). The mean sacral indexes (table-1) of the male & female sacra in the present study are 101.26% & 116.18% respectively which falls under Hyplatyhieric & Platyhieric groups respectively. Almost similar observations were reported by Poornima J[8] et.al (male: 104.08% & female: 115.72%), Asthana S et.al (male: 96.25 & female: 113.33), Raju PB et.al and Davivongs V. Mishra SR et al, in his study has classified the male sacra (SI: 98.22 %) under Dolichochieric group and female sacra (SI: 117.84 %) under Platyhieric group which is almost similar to the present study. The mean sacral index reported by Mamatha H[9].et al in male and female was 115.92% & 125.2% respectively, which was higher when compared to present study. The mean sacral index reported by Patel MM[10] et.al in male and female was 96.25 & 113.25

respectively. The average sacral index for British males[11] is 112 and for females is 116. Indexes above 100 class the sacra as Platyhieric, those with indexes below 100 being Dolichohieric. The gorilla gives a sacral index of 72.

Present study showed that according to sacral index method, 84% (42) of male sacra were identified, and 52% (26) of female sacra were identified accurately. Patel MM[10] et al. also showed that 62.5% of male sacra and 68.75% of female sacra were identified using sacral index method. Bindra GS & Mohan A[12] also showed that 66.6% of male sacra and 70% of female sacra were identified using sacral index method.

CONCLUSION

The present study showed a significant difference among the average male & female sacral indexes and considers sacral index as a valuable parameter in identification of sex. The male & female sacra are classified under (Dolichohieric & Hyplatyhieric) and Platyhieric group respectively. Hence, it can be concluded that sacral index is a reliable criterion for differentiation between sexes of sacrum that is useful for Anatomists.

Conflicts of Interests: None

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