

ORIGINAL RESEARCH

Significance of Sacral Index in Sex Determination of Sacrum and Its Comparison with Different Regions of India

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ABSTRACT

Background: Sex determination from skeletal remains is of great significance for Forensic experts, archeologist and anthropologists for identification of the deceased. Although many bones exhibit clear cut sexual dimorphism but to determine the sex with 100% accuracy, metric measurements are to be used. These indices and their demarking points exhibit significant variation in range according to geographic location & ethnicity. Hence several studies are carried out to calculate anthropometric data regarding various measurements & indices for a particular region. **Aim:** To assess reliability of sacral index in sex estimation and comparison with Sacral index of various regions of India. **Materials & Methods:** 100 fully ossified adult human sacrum of known sex (58 male and 42 female) was collected from Department of Anatomy, SMS Medical College, Jaipur, Rajasthan. Measurements were taken by using sliding venire caliper. DP (demarking points) were calculated. Data collected were statistically analyzed. **Results:** The average value of sacral index for male was 96.25 and 113.33 for females. Present study concluded that by using sacral index as a single parameter 46.55% male and 57.14% female sacra were identified as male and female respectively. **Conclusion:** For sex determination of sacrum, maximum numbers of parameters should be considered.

Key Words: Sacral Index, Sex Determination, Venire caliper, demarking point.

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INTRODUCTION

In establishing personal identity with respect to sex, anatomist, forensic experts and Anthropologist use skeletal remains for giving their opinion in medico-legal cases and in archaeological specimens. According to Krogmann bony pelvis is the best bone for distinguishing sex with 90-95% accuracy [1].

As Sacrum, a triangular bone, wedged between two hip bones is forming postero-superior wall of pelvic cavity [2]. As an integral part of pelvis, sacrum also demonstrates sexual dimorphism that is why it has been used by forensic experts and anthropologist for sex estimation.

Jit and Singh (1966) advocated demarking point to identify the sex of bones [3]. Various studies suggested calculating demarking point separately for different regions because mean value of parameters are different in different regions [4-7]. A comparison and verification of the findings over a geographical

distribution is of prime importance and this study is an attempt to assess the reliability of sacral index in sexing and to compare the regional differences in sacral index.

MATERIALS AND METHODS

This study was done on 100 dry, adult human sacrum of known sex (58 male and 42 female) in the Department of Anatomy, SMS Medical College, Jaipur, Rajasthan. Fractured, pathological or unossified sacra were excluded from the study. Breadth and length of sacrum were measured with the help of sliding steel venire caliper.

The stem of caliper was applied to upper surface of the sacrum and maximum breadth was measured across the greatest expanse of lateral masses of the bone [5] as shown in Figure 1.



Figure1: Measurement of breadth of sacrum

Maximum length of sacrum was taken along the mid-line of sacrum from middle of antero-superior margin of promontory to middle of antero-inferior margin of the last sacral vertebra [5] as shown in Figure 2.



Figure2: Showing measurement of length of sacrum.

3. By using the above measurements, sacral index was calculated by using the formula—

$$1. \text{ Sacral index} = (\text{sacral width} / \text{sacral ventral straight length}) \times 100$$

The mean, Standard deviation (S.D.) were calculated and Demarking Points (D.P.) were estimated from these values and the percentage of the bones thus identified, were found out in relation to each parameter.

For identification of Male sacrum, the demarking point (D.P.) of a particular measurement was less than 3 S.D. of mean value of female, and for female sacrum, the D.P. of same measurement was more than 3 S.D. of mean value of male.

RESULTS

It was found that length of sacrum was higher in males, but sacral index and breadth was higher in females. The mean difference in length and sacral index of sacrum of two sex statistically differ highly significantly i.e. $P < 0.001$. But the mean difference in breadth of bones of two sex statistically do not differ significantly i.e. $P > 0.05$. [Table no.1 and 2].

The percentage of bones identified by sacral index method (using demarking point) was 46.55 for males and 57.14 for females (Table-2).

Table1: Mean \pm 3Sd of length and breadth

Parameters	Male	Female	P-value	Significance
Length	106.96 \pm 6.88	90.52 \pm 3.91	< .001	HS
Breadth	103.07 \pm 9.00	102.67 \pm 7.41	> .05	NS

Table 2: All the Parameters of Sacral Index

Parameters	Sex	
	Male	Female
Range	85-106	100-126
Mean	96.25	113.33
Sd	5.45	5.57
Mean \pm 3Sd	79-90 – 112.60	96.62 – 130.04
Demarking point	< 96.62	> 112.60
No. of bone	27	24
Percentage of bone	46.55	57.14

Table 3: Comparison for maximum length, breadth and sacral index of present study with other studies of different regions of India.

Parameters /Study	Region	No. of bone	Length of male sacrum mm	Length of female Sacrum mm	Breadth of male Sacrum mm	Breadth of female Sacrum mm	Sacral index Male	Sacral index Female	% of bones identify by DP	
									Male	Female
Mazumdar 2012	West Bengal	250	100.8	87.3	96.3	95.6	94.9	109.8	9.4	44.7
Patel S 2014	Madhya pradesh	126	109.47	94.46	106.42	97.61	100.24	117.4	-	-
Kataria S 2014	Western Rajasthan	74	106.7	91.91	110.3	109.88	104.11	120.01	61.9	48

Maddikunta 2014	Telangana	60	113.9	90	104.2	103.4	91.8	116.3	3.7	9.1
Somesh 2015	South india	87	113.88	91.29	105.21	102.66	92.71	113.06	16	77
Bindra 2015	Haryana	60	106.85	90.89	108.24	106.87	101.3	117.56	66.7	70
Arora AK 2015	Panjab	40	109.74	91.22	101.94	114.13	93.68	125.35	45	40
Yadav 2015	Maharashtra	140	104.7	92.6	102.93	104.77	98.44	113.23	62.5	68.75
Dubey 2016	Madhya pradesh	60	113.5	94.6	105.83	104.33	101.3	117.56	53.33	46.67
Parashuram 2018	Karnataka	100	102.68	91.11	103.8	105.57	101.26	116.18	53.33	46.67
Maharia 2019	Gujrat	50	102.58	111.74	103.21	102.34	99.68	109.36	79.17	65.67
Bisht K 2020	Uttarpradesh	32	111.53	102.54	93.46	102.05	92.37	109.52	-	-
Vani G 2020	Andhra Pradesh	42	96.739	95.894	96.521	99.842	101.14	103.66	-	-
Kumar B 2021	Bihar	110	104.55	94.66	101.53	105.67	97.66	112.12	17	42
Present study	Central Rajasthan	100	106.96	90.52	103.07	102.67	96.25	113.33	46.55	57.14

DISCUSSION

Actually, very little data is available to test the validity of the number of parameters described to identify the sex of sacra. (Davivongs, 1963)[8]

But several studies suggested that sacral index is the most reliable parameter for sexing.

Jit and Singh (1966) identified sex of sacrum with 100% accuracy by calculating demarking points from the observed values [3].

In present study, the values of length, breadth and sacral index of both the sexes were compared with previous studies of various regions of India (Table no.3).

In our study, mean valuesacral length of males (106.96mm)was greater than that of females (90.52).The mean difference in length of bones of two sex differ statistically i.e. $P < 0.001$.

Mean Length of male Sacra --In our study mean length of males (106.96mm) which is comparable to studies done on populationof Haryana (106.85mm) by Bindra et al[9], western Rajasthan(106.7mm) by Kataria et al [10],Maharashtra(104.7mm) by yadav et al[11],Bihar (104.55mm) by Kumar B et al[12],Karnataka (102.68mm) byParshuram et al[13] and in Gujrat (102.58mm) by Maharia P et al[22].

Mean length of male sacrum was found to be higher in populationof Telangana(113.9mm) by Maddikuntha et al [14], south Indian population 113.88mm by Somesh et al [15],Panjab109.7mm by Arora AK [16],andMadhya Pradesh 109.47mm in by Patel S [17].

Mean Value of length of male sacrum was lowerin Andhra Pradesh (96.73mm) and West Bengal (100.8mm) population, studies done by Vani G [18] and by Mazumdar et al [19] respectively.

Mean Length of female Sacra-- In present study mean length of female sacrum was 90.52mm which is comparable to studies done in South India, Telangana, Maharashtra, Haryana and Panjab [9,12,13,14,15,17,18]. Values were higher, in studies [15,16,19,20] done in Gujarat, Madhya pradesh, Uttar pradesh, Bihar regions. Length of female sacrum was found to be minimum (87.3mm) in West Bengal population [20].

Mean breadth in male and female sacrum —In present study mean breadth of male sacrum 103.07mm and of female sacrum 102.67mm was observed. This infers insignificant difference between the males and female sacral breadth. Similar observation obtained by most studies[10,12,14,16,17,20,21,24], except studies done by KumarB in Bihar[12], Arora et el in Punjab[16], Patel S in MadhyaPradesh[17].

Mean length (100.8 for male, 87.3 for female) and breadth of sacrum were minimum in study of Mazumdar et al, in west Bengal region (96.3 for males, 95.6 for females) [19].

Sacral Index—Gray's Anatomy (40th edition) gives the mean value of sacral index to be 105 in males and 115 in females [2]. In present study mean value of sacral index for males was 96.25 and 113.33 for females.

These values were comparable to study of KumarB et al in Bihar population[12]

Sacral index for male --Sacral index found to be maximum for male in western Rajasthan region (104.11 by Kataria et al and minimum in Telangana region (91.8) by Muddikunta et al. [10,14]

Sacral index for female-- Maximum value of sacral index for female was observed in Panjab by Arora et al and minimum in Andhra Pradesh(103.66) by Vani G

[16,18]. Thus there exists a regional and racial difference in the measurements of sacrum.

In present study Range of sacral index for male was 85-106 and 100-126 for females. Demarking point for sacral index for male was <96.62 mm and for female was > 112.60 mm. 46.55 Percent male and 57.14 Percent female sacra confirmed by using Sacral index method.

Mazumdar et al study, show that according to sacral index method using demarking point 9.4 % male and 44.7% female were identified, [19], Patel MM et al also showed that 62.5% of male sacra and 68.75% of female sacra were identified [20]. Bindra GS & Mohan A observed that 66.6% of male and 70% of female sacra [9] identified, Somesh et al 16% male and 77 % female sacra [15], Yadav et al 62.5% male and 68.75% female sacra [11], Kumar B et al 17% male and 42% female [12], Mishra et al 39.2% male and 80.1% female sacra [6], Shreekrishna H 56% male and 78% female sacra [21] were identified using sacral index method. In these studies accuracy for female sacra identification was more as compare to male sacrum.

But some studies like Arora et al 45% male and 40% of female sacra [16], Parshuram et al 84% male and 70% female [13], Dubey et al 53.33% male and 46.67% female [23], Kataria et al 61.9% male and 48% female [10] and Maharia et al 79.17% male and 65.78% female sacra [22] were identified. Here accuracy for male identification was slightly higher than female identification [18].

Regional studies are constructive in the observation of the anthropometric trends that may be influenced by environmental, racial and genetic factors of the region and have immense importance in Forensic Medicine and Anthropology in addition to Anatomy [24].

This difference of the obtained values of Sacral index between the male and female sacra was found to be statically significant in most of the studies including mine except by Vani G in Andhra Pradesh where no significant difference was there. [18].

The most important criteria for sex determination using sacrum is 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.

CONCLUSION

For sex determination of the sacrum with maximum number of parameters are taken into consideration as some of parameters are insignificant for sexing. Also, demarking points helps in sex determination of bones with greater accuracy. Significant variations according to geographic location exists so conduction of such studies in a defined geographic area over a period of time will definitely help in establishing anthropometric standards and will be useful for anatomical, medico-legal and anthropological purposes.

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