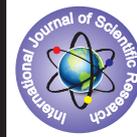


Multicentric Study of Sacral Index in Dry Human Sacra in Madhya Pradesh Region.



Anatomy

KEYWORDS: Sacral Index, Demarking point, Identification point

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ABSTRACT

Morphological features of bones depend on the nutritional, geographic, racial and occupational factors, hence vary in different regions. Sacrum is usually being last available skeletal remain, proves important in sexing and forensic identification. Sacral Index is considered to be most important and widely used derived indicator for sexing the sacra. Study was conducted on 282 dry human sacra to derive sacral index and demarcation point for identification of sex of dry human sacra in Madhya Pradesh region. Ventral Straight length and maximum transverse width were measured using digital calipers and were statistically analyzed to derive Sacral index and demarking point. Mean sacral index of male and female sacra was 95.08 and 107.86 with demarking value of <74.15 and >118.87 respectively. This study may act as prelude of comparative morphometric studies in future and useful for anatomists, anthropologists, forensic and medicolegal experts.

Introduction –

Human sacrum is a large triangular bone formed by fusion of five sacral vertebra and forms posterosuperior wall of the pelvic cavity wedged between two innominate bones. [1] sacrum is one of the bones where such sexual dimorphism is widely evident. Anatomist, anthropologists and forensic experts use to judge the sex by non metric observations of the different bones available and later confirmed by actual measurements. Earlier researchers like Pearson, Fisher, Stewart and Krogman studied accuracy of sex identification on basis of study of individual bones. According to Krogman(1962) the degree of accuracy in sex identification on basis of complete skeleton was 100%, pelvis with skull 98%, pelvis alone 95%, skull alone 90% and long bones alone 80%. [2]

Morphological features of bones vary in different regions because of nutritional, geographic, racial and occupational factors. Sacrum is usually being last available skeletal remain, proves important in sexing and forensic identification.[3] Population in Indian subcontinent shows wide variety of pure ethnic groups and various confluences of different racial characters that are difficult to be generalized under one pattern. Various sacral anthropometric studies for the regional divisions like north, south, east and west india are available showing significant differences in the mean values. Madhya Pradesh being the region geographical, racial and nutritional diversity along with presence of pure ethnic groups may show sexual and regional differences in the local population. So, present study was conducted on dry human sacra including various regions of Madhya Pradesh so as to take geographical, regional, nutritional, racial differences into account.

Objective –

The study was conducted to derive sacral index and demarking values for identification of sex of dry human sacra in Madhya Pradesh region.

Material and methods –

After necessary permission of institutional ethics committee, the study was carried out under the purview of Department of Anatomy, Gandhi Medical College, Bhopal, M.P., India from Jan 2015 to July 2016 on 282 dry human sacra collected and studied at Department of Anatomy, Gandhi Medical College, Bhopal (M.P.), Department of Forensic medicine and Toxicology, Gandhi Medical College, Bhopal (M.P.), Regional Medicolegal Institute, Bhopal(M.P.), Department of Anatomy, NSCB Medical College, Jabalpur (M.P.), Department of Anatomy, SSMC, Rewa (M.P.), Department of Anatomy, Pt. J.N.M. Medical College, Raipur (C.G.), Department of Anatomy, CIMS, Bilaspur (C.G.), Department of Anatomy, Horizon Dental College,

Bilaspur (C.G.) after due desirable permissions. All available completely ossified dry human sacra without any visible variation or damage were taken for study purpose. Variant sacra and broken sacra were excluded from the study. After obtaining two groups from cluster analysis, following measurements were taken using digital sliding vernier caliper. [4]

1. Ventral straight length – (Maximum length of sacrum) - It measures the straight distance between the sacral promontory in the mid sagittal plane to the corresponding lowest point on the anterior margin of the sacrum.

2. Width of sacrum (Maximum breadth) – It measures two points at the lateral most part of the ala of sacrum.

3. Sacral index =
$$\frac{\text{Maximum width} \times 100}{\text{Maximum straight length}}$$

Identification point for each measurement is calculated as above or below the maximum or minimum value of observation for the sacra of opposite gender. Calculated Range was derived as $\text{mean} \pm 3S.D.$ Demarking point for each measurement is above or below the maximum or minimum value of calculated range for the sacra of opposite gender. Student t- test is applied for significance.

Results –

Mean value for the mid ventral straight length in male is 11.24cms and for females is 9.44cms. The demarking point for male sacra is >11.57cms and for female sacra is <8.93cms. Thus, sacrum with mid ventral straight length measuring above 11.57cms is definitely a male and below 8.93cms is definitely a female. Mean value for the width (maximum transverse length) in male sacra is 10.65cms and 10.13cms for female sacra. The demarking point is <7.96cms for male and >12.59cms for female sacra. Sacrum with width (maximum transverse length) measuring below 7.96cms is definitely a male and above 12.59 cms is definitely a female. On the basis of mid ventral straight length and maximum transverse length sacral index was derived.

Table -1- Sacral Index

Derived Measurements	Male	Female
70 – 79.99	5 (3.4%)	1 (0.7%)
80 – 89.99	29 (19.9%)	5 (3.7%)
90 – 99.99	76 (52.0%)	26 (19.1%)
100 – 109.99	27 (18.5%)	45 (33.1%)
110 – 119.99	9 (6.2%)	44 (32.3%)

120 – 129.99	0	9 (6.7%)
130-139.99	0	6 (4.4%)
Total No. of bones	146	136
Range	76.90 - 115.52	71.19 – 139.97
Mean	95.0825	107.864
Std. deviation	7.9292	11.2358
Identification point	>139.97	<76.90
Calculated range	71.29 – 118.87	74.15 – 141.57
Demarking point	<74.15	>118.87
Percentage beyond DP	0	5.67%
% of identified bones	0	0.73%

Mean sacral index for male and female is 95.0825 and 107.864 with standard deviation of 7.9292 and 11.2358 respectively. It signifies frequency concentration 76 (52.0%) in range 90- 99.99 in males and frequency dispersion in female 45 (33.1%), 44 (32.3%) and 26 (19.1%) in range 100 – 109.99, 110 – 119.99, 90 – 99.99 respectively. The demarking point is <74.15 for male sacra and >118.87 for female sacra. Sacrum with sacral index measuring below 74.15 is definitely a male and above 118.87 is definitely a female. 5.67% female sacra do not overlap in the respective ranges of this parameter. In overlapping ranges the study of other measurements of sacra and study of other bones if available in addition to sacrum, helps in determination of sex with greater certainty. Mean value for male sacra is significantly lower than that in female sacra. The sex difference in mean values of sacral index in male and female is statistically highly significant, t-value is calculated to be 11.095(p<0.0001).

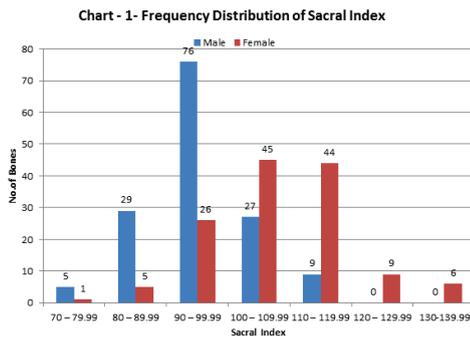


Table – 2 – Grouping of sacra by Sacral Index [5]

Classification	Range	Male (n=146)	Female (n=136)
Dolichohierisch (Narrow)	<99.9	110 (75.3%)	31 (22.8%)
Hyplatyhierisch (Medium)	100 – 105.9	25 (17.1%)	31 (22.8%)
Platyhierisch (Board)	>106	11 (7.6%)	74 (54.4%)

Discussion -

The mean sacral index in male sacra observed in present study are compared with those reported in the literature by various authors in different populations is represented in table-3. Present findings nearly matched with those of Mishra et al (2003). In the European sacrum mean values of both male and female fall into the Platyhierisch group. The values of sacral index observed in the present study are higher than that of values reported by Mishra and Singh in Agra and Varanasi regions [6], Kanika et al in Amritsar, Punjab region [7], Vinod Kumar et al [8], Jana et al in Burudhwan region [9], Dapate et al [10], Bagde [11], Patel et al [12], Raju et al [13]. The mean values of sacral index are minutely lower than that of Australian aborigines [14], Flander in whites and in blacks [15], lower than that reported in text-books Gray’s Anatomy.[1, 5].

The comparison of values of sacral index in male in the Patel et al [12], Mishra in Agra [6], Vinod Kumar et al [8], Jana et al in region of Burudhwan [9], and present study comes under Dolichohierisch group (value is <100). Davivongs in Australian aborigines [14], Kanika et al [7], Raju et al [13] and Jyotinath K et al [16] comes under Hyplatyhierisch group [between 100-105.9] whereas Flanders in Whites and Blacks [15] and Martin in under Platyhierisch

group;>106. [Table-2].

The mean sacral index in female sacra in Agra region by Mishra et al [6] is 117.84, in Varanasi region is 104.8, in Australian aborigine by Davivongs [14] is 115.49, by Gray’s Anatomy [1] is 115.49, by Flanders [15] in whites is 108.69 and in blacks is 112.35, by Raju et al [13] is 113.39, by Bagde [11] is 112.05, by Vinod Kumar et al [8] is 103.89, by Jana et al [9] is 103.89, by Dapate et al [10] is 104.27 and by Kanika et al [7] is 111.74, whereas in the present study it is 107.86 that is low compared to the Mishra in Agra region [7], Raju et al [13], Bagde [11], Charnalia [17], Flander[15] in white and black, Australian aborigines [14] and Kanika et al [7]. But, it is higher than that reported by Vinod Kumar et al [8], Jana et al in region of Burudhwan [9] and Dapate et al [10].

The male sacra show a mean sacral index of 95.08 that is low when compared to female sacra that show a mean sacral index of 107.86 in the present study. Even in the present study the difference between male and female values is extremely significant (p<0.0001). In female sacra, Vinod Kumar et al [76], Jana et al in region of Burudhwan [60], Dapate et al [49] comes under Hyplatyhierisch group (values in the range of 100-105.9) and present study comes under Platyhierisch group(>106) [Table-2]

Table – 3 - Comparison of present study with other studies for Sacral Index

Previous Researchers	Male				Female				S.S.D. P
	N	x	Range	S.D.	N	x	Range	S.D.	
Martin (1928) [5]	-	112.14	-	-	-	-	-	-	-
Grays Anatomy (1954)[1]	-	105	86.9-123.2	8.93	50	115.49	96.2-140	10.3	<0.001
Davivongs (1963)[14]	50	104.16	86.9-123.2	8.93	50	115.49	96.2-140	10.3	<0.001
Charnalia (1967)[17]	60	105.1	-	-	30	112	-	-	-
Flander (1978)[15]									
White	50	106.49	-	10.40	50	108.69	-	13.59	N.S.
Black	50	106.17	-	10.36	50	112.35	-	11.03	<0.01
Raju et al (1980)[13]	33	100.85	74.72-126.9	8.71	11	111.39	88.38-134.4	7.67	<0.001
Bagde (1981) [11]	65	94.75	80.2-114	7.15	30	112.05	90.8-133.3	10.9	<0.001
Vinod Kumar et al (1984) [8]	-	91.27	-	-	-	103.89	-	-	-
Jana et al (1987)[9]	-	91.27	83.3-112.5	-	-	103.89	89.61-115.7	-	-
S.S.Dapate (1997)[10]	117	94.58	77.27-118.42	6.96	83	104.27	85.0-136.36	10.675	0.05
Mishra (2003) [6]	74	98.21	90-108	4.89	42	117.84	103.0-131.25	7.00	
Kanika S et al (2011) [7]	40	100.24	78.04-149.56	12.54	10	111.74	88.79-140.48	14.6	0.016
Jyotinath K et al (2012) [16]	45	104.08	81-136	16.5	36	115.72	85-146	13.64	0.000
Maddikunta V et al(2014) [18]	27	91.8	83.1-97.38	4.99	33	116.3	101.77-132.15	9.51	<0.01
Present study	146	95.08	76.9-115.5	7.92	136	107.86	71.19-139.97	11.235	<0.001

Conclusion –

After a detailed study, it can be concluded that metric methods help in sexing the sacrum with greater accuracy than non metric methods. The demarking point of mid ventral straight length of sacrum is more reliable measurement in comparison to maximum transverse length (width) of the sacrum. Sacral Index is most

important derived parameter for distinguishing male and female sacra. Based on the overlapping and variations observed among the measurements, the demarking points of a single parameter may not identify sex in all the bones, but the accuracy is high in the bones which are identified. t-value and p-value indicate mid ventral length to be most valid single measured parameter for identification of sex of sacra. This study will help anatomists, forensic experts and anthropologists in determining sex of the sacra and act as a prelude to future comparative morphometric studies.

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