

Study of Various Sacral Indices for Sexual Dimorphism in Sacrum

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Abstract

Determination of sex is an integral first step in the development of the biological profile in human osteology. The general anatomical regions used for sex determination are the pelvic girdle, skull and long bones, although other bones have also been utilized [1]. The developmental age changes are different in male and female bones including sacrum [2]. The pelvic girdle is the most accurate area to determine sex and methods using the pelvic girdle tend to make successful predictions in 90 to 95 percent of individuals [3]. In our study 100 sacra of both sexes were compared for Body of First Sacral Vertebra (S1), sacral index, curvature index and auricular index. The results show Index of Body of First Sacral Vertebra (S1) in male is 62.53 and in females it is 54.74. Sacral Index in male is 97.45 and in females it is 101.49. One way ANOVA shows 0.001 significance suggesting statistically highly significant difference in male and female for both sacral index and Index of Body of First Sacral Vertebra (S1). Curvature Index in male is 100.57 and in females it is 99.33. One way ANOVA shows f value as 3.650 which was statistically significant. Auricular index in male is 51.34 and in female it is 50.11. One way ANOVA shows f value as 1.037 which was not significant statistically. The results show that Index of Body of First Sacral Vertebra (S1), Sacral index and curvature Index are more reliable parameters than auricular index for sexual dimorphism assessment.

Keywords: Sacrum; Sexual Dimorphism; Parameters; Sacral Index; Index of Body of First Sacral Vertebra (S1); Curvature Index; Auricular Index.

Introduction

The sacrum is a large, triangular bone of pelvis. It is present on the postero-superior wall of the pelvic cavity, wedged between the two innominate bones. It is formed by fusion of five vertebrae [4].

Sexual dimorphic characters can be studied both morphologically and metrically in the determination of personal individuality from adult human skeletal remains. The sacrum has always attracted the

attention of medicolegal experts for establishing the sex due to its contribution to the pelvic girdle and associated sex differences, which are augmented due to reproductive functions, mainly influenced by sex hormones [5].

The female sacra are shorter and wider and make the pelvic cavity broad. By measuring the length and width of sacrum, sacral index can be calculated and on the basis of this index, the sacrum can be divided into three groups (vide Wilder's manual of Anthropometry).

The three groups were Dolichohieric: sacral index < 100 (up to 99.99), Sub-plathyhieric: sacral index 100-106, Plathyhieric: sacral index > 106. It is observed that a very little work is done on sacrum [6], hence; the present work is an attempt to establish role of various parameters and indices like sacral index, index of body of first sacral vertebra, curvature index and auricular index which will be of great help in sex determination in anthropometric & medico legal study, of a defined area over a period of time.

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Material and Method

The present study was carried out at Department of Anatomy, Government medical college Aurangabad and MGM medical College, Aurangabad. Approval was obtained from Institutional Ethical committee.

Written permission was taken for collection of 100 sacra of both the sexes from HOD Department of Anatomy, Govt. Medical College and MGM medical College, Aurangabad. Non ossified and fragmented sacra were excluded from the study.

The sliding Vernier caliper with scale graduated from 0 to 150 mm of Mitutoyo absolute digimatic company, made in Japan was used to measure minimum Sacral width, maximum Sacral width, transverse diameter of body, Antero-Posterior Diameter of Body of First Sacral Vertebra, Straight Length, Length of Auricular Surface. Mid Ventral Curved Length was measured by standard measuring tape.

1. Maximum sacral width: The straight distance between two points at the lateral most part of alae of sacrum.
2. Minimum sacral width: Minimum transverse distance measured midpoint of fourth and fifth sacral vertebra, near the apex.
Width of sacrum was calculated by taking average of maximal and minimal sacral width.
3. Transverse diameter of the body of the first sacral vertebra was measured by taking one point on each side of the lateral most point on the superior surface of the body of first sacral vertebra.
4. Antero-Posterior Diameter of Body of First Sacral Vertebra was measured by taking one point on the antero-superior border and other on the postero -superior border and was measured by Vernier caliper.
5. Straight Length: It was measured along the midline of sacrum with the Vernier calliper from

the middle of the antero-superior margin of sacral promontory to middle of antero inferior margin of last sacral vertebra.

6. Mid Ventral Curved Length: It was measured It was measured by using the flexible Ribbon tape along the ventral concave median length in centimeters from midpoint of sacral promontory to the midpoint of apex of sacrum.
7. Length of Auricular Surface: It was measured on lateral aspect of sacrum. One point is on the uppermost part of auricular surface and second on its lower most part .The mean length of two sides is taken as maximum length of auricular surface.
8. Indexing: Sacral Index, Index of Body of First Sacral Vertebra (S1), Curvature Index, Auricular Index were calculated by formulas [3] given below-

1. Sacral Index=

$$\frac{\text{Width} \times 100}{\text{StraightLenth}}$$

2. Index of body of 1st Sacral vertebra =

$$\frac{\text{AP Diameter of body of S1} \times 100}{\text{Transverse dia. of body of S1}}$$

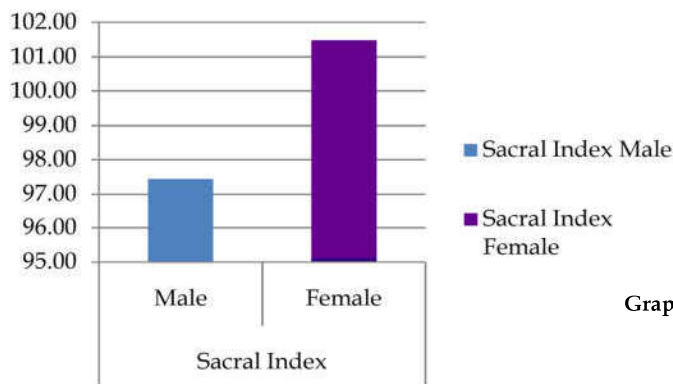
3. Curvature Index=

$$\frac{\text{StraightLenth} \times 100}{\text{Mid Ventral Curved length}}$$

4. Auricular Index=

$$\frac{\text{Length of auricular surface} \times 100}{\text{Width of Sacrum}}$$

The parameters and indices were analysed statistically by using SPSS 19 software and compared for multivariate analysis.



Graph 1: Sacral Index

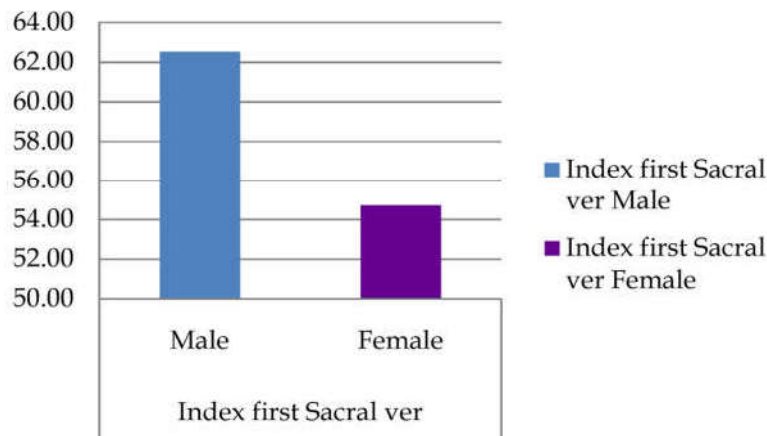
Table 1:

Parameter	Sex	Mean \pm SD	ANOVA(f)	p value
Sacral Maximum width (mm)	Male	106.46 \pm 6.08	22.918	0.000***
	Female	98.00 \pm 10.72		
Sacral minimum width (mm)	Male	61.49 \pm 8.49	3.446	0.66 (NS)
	Female	57.94 \pm 9.98		
Transverse Diameter of Body of First Sacral Vertebra (mm)	Male	48.57 \pm 5.61	29.362	0.000***
	Female	41.20 \pm 7.53		
Antero-Posterior Diameter of Body of First Sacral Vertebra (S1) (mm)	Male	30.13 \pm 3.27	49.824	0.000***
	Female	22.69 \pm 7.07		
Straight Length (mm)	Male	108.30 \pm 8.86	39.547	0.000***
	Female	95.19 \pm 13.24		
Mid Ventral Curved Length (mm)	Male	109.61 \pm 10.16	27.722	0.000***
	Female	97.12 \pm 9.34		
Length of Auricular Surface (mm)	Male	54.50 \pm 5.07	35.570	0.000***
	Female	49.07 \pm 4.58		
Sacral Index	Male	97.45 \pm 7.09	11.168	0.001***
	Female	101.49 \pm 11.59		
Index of Body of First Sacral Vertebra (S1) (mm)	Male	62.53 \pm 10.40	11.776	0.001***
	Female	54.74 \pm 14.32		
Curvature Index (mm)	Male	100.57 \pm 8.39	3.650	0.049**
	Female	99.33 \pm 10.91		
Auricular Index (mm)	Male	51.34 \pm 4.92	1.037	0.311 (NS)
	Female	50.11 \pm 7.33		

*** - statistically highly significant

** - statistically significant

NS - not significant



Graph 2: Index of Body of First Sacral Vertebra (S1)

Result

The mean, standard deviation and test of significance were calculated from the data by using SPSS version 19 for the identification of sex using the parameters mentioned above.

It is observed that mean of sacral maximum width in male is 106.46 and in females it is 98.00 this shows that sacral max width is more in males as compared to female. Sacral minimum width in male is 61.49 and in females it is 57.94 this shows that sacral

minimum width is more in males as compared to female though not significant statistically.

It is observed that mean of Transverse Diameter of Body of First Sacral Vertebra in male is 48.57 and in females it is 41.20 this shows that Transverse Diameter of Body of First Sacral Vertebra is significantly more in males as compared to female. The mean AP diameter of First sacral vertebra in male is 30.13 and female is 22.69mm with the difference being statistically highly significant. The mean ventral straight maximum length (straight length) in male is 108.30mm and in female is 95.19mm. The difference

between both sexes is statistically significant. Mean Mid-ventral curved length was 109.61 in male and 97.12mm in female with the difference being statistically highly significant. Mean length of auricular surface in male was 54.50 and 49.07 in female sacra. The difference was found to be highly significant.

Discussion

Determination of sex is an integral first step in the development of the biological profile in human osteology. In present study most of the parameters show significant sexual dimorphism.

The parameters like sacral maximum width, sacral minimum width, ventral straight length, mid ventral curved length, transverse and AP diameter of body of first sacral vertebra, maximum length of auricular surface show significant variation in male and female sacra. Indices like Sacral index, Index of body of first sacral vertebra and curvature index showed statistically significant variation in male and female sacra and can be successfully utilized for sexing of the sacrum.

In the present study the mean sacral index in male sacra, is higher than that of Gray's Anatomy [4], Charnalia [7], Flander [8], Kothapalli [9] and lower than that Bagde [10], Vinod Kumar et. al [11], Jana et. al [12], Singh et al [13], S.S. Dapate [14] and Shailja Math [15]. Present study is comparable with Raju et al [16] and Kanika et al [17].

The mean sacral index in female sacra in present study is higher than that observed in Grays anatomy [4], Charnalia [7], Flander [8], Raju et. al [16], Bagade [10], Shailja Math [15], Kanika et. al [17], Kothapalli [9].

Present study is comparable with studies by Singh et. al [13], Jana et. al [12], vinod kumar et. al [11], Flander [8], S.S. Dapate [14] and Mazumdar et. al [18].

Index of body of 1st sacral vertebra is significantly higher in males as compared to females in our study. When compared with other studies mean Index of body of first sacral vertebra in male is higher than the studies by S.S. Dapate [14], Kothapalli et. al [9] and Mazumdar et. al [18], and it is lower than study done by Shailja Math [15].

The result in present study was almost equal with studies by Raju et. al [16] and with Bagde [10]. Mean Index of body of first sacral vertebra in female was found to be lower than the studies by Raju et. al [16], Bagde [10], S.S Dapate [14], Shailja Math [15], kothapalli [9] and Mazumdar et. al [18].

In present study mean curvature index in male and female was found to be higher than studies by Kanika et. al [17], Mazumdar et. al [18], Kothapalli et. al [9] and Shreekrishna HK [19]. In present study mean Auricular index is found to be lower than that the study done by Kothapalli [9] in case of both male and female.

Sacral parameters like sacral index, Index of body of first sacral vertebra, curvature index in our study are more significant parameters than auricular index for sexual dimorphism in sacra.

Conclusion

The present study has very significant role to determine appropriate indices of sexual dimorphism for sacral bone. The study concludes that no single index can identify sex of sacrum accurately so we suggest use of multiple indices for sex determination of sacral bone over any single index.

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