A study on sacral index and its uses in sex determination

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ABSTRACT

The human sacrum is a complex structure and provides accommodation for spinal nerves which stabilises the pelvis. Morphometric measurements of sacrum determine the sex of the individual. The measurement of sacral index using the sacrum bone is considered as one of the best methods for determination of sex. The aim of this study is to find out the importance of sacral index in sexual dimorphism and to compare the findings with various age groups. 100 fully ossified sacral bones were collected from department of Anatomy. Average sacral length and breadth were taken by using sliding Vernier caliper and sacral index was calculated. The obtained values were tabulated against their respective parameters and then interpreted for the study. Average sacral index in females (109) is significantly greater than males (94). As per present study sacral index can reliably identify 58% of male sacrum and 42% of female sacrum. It is therefore a quite reliable and significant criteria for sex determination of sacrum. Thus, regional and racial differences in sacrum along with sacral index can be used for anatomical, medico-legal and anthropological purposes.

INTRODUCTION

The word meaning of “Sacrum” is “sacred” in Latin, “hieron osteon”, (holy bone) in Greek language. During development, five individual sacral vertebrae fuses to form a single large bone called as sacrum which is sandwiched between two hip bone in the pelvic region. Sacrum plays protective role to pelvic region structures, very specifically movement of it during paturation in females (Horan, 2009). Identification of gender; age and stature, can be done with the knowledge of sacral morphometry which is an essential tool for medico legal experts, anatomists and anthropologists. Easy method to determine the sex of the skeletal material is by conventional method of observations usually done by experienced anatomists, anthropologists and forensic experts (Krishna, 2007).

Gender differences have been noted in the pelvic bone anatomy, and so significant variations exist in male and female sacrum (Cheng and Song, 2003). Various authors had carried out different types of measurements on human sacrum. But the already existed method for determination of sex of the individual is Sacral Index. Geographical and racial variation do exist in the measurement of sacrum (Davivongs, 1963; Singh, 1968).

The aim of this study is to find out the importance of...
Figure 1: Morphometry of sacrum, A- Length of sacrum, B- Breadth of Sacrum, C- Tranverse Diameter, D- Antero-Posterior Diameter

The values obtained were tabulated and interpreted for the study of identification of the sex of the sacral bone in sexual dimorphism and to compare the findings with various age groups. The objective of this study is to find the metrical characters of the human sacrum by means of which sex determination of this bone is as precise as possible. The data regarding morphometric measurements of sacrum was collected and the possible variations of sacral index in relation to sex were identified.

MATERIALS AND METHODS

100 fully ossified sacral bones were collected from the department of Anatomy. The study was analyzed, reviewed and approved by Institutional review board in Saveetha Medical College & Hospital. Each sacrum was assigned a number. Using a thread, the following parameters were measured in the adult sacra: length of the sacrum (Figure 1), width of the sacrum (Figure 1), transverse diameter of body of S1 (Figure 1), antero-posterior diameter (Figure 1), sacral index, index of the body of 1st sacral vertebrae. Average sacral length and breadth were taken by using a thread and the sacral index was calculated. In order to prevent observer’s error, all the parameters were measured and recorded by single observer. For each of the parameters, three readings were taken and then their average was taken as final reading. The obtained values were tabulated against their respective parameters and then interpreted for the study.

Formulas used

\[ \text{Sacral Index} = \frac{\text{Length of ala}}{\text{Transverse diameter of body of } S1} \times 100 \]

\[ \text{Index of body of 1st sacral vertebrae} = \frac{\text{AP diameter of body of } S1}{\text{Transverse diameter of body of } S1} \times 100 \]

\[ \text{Alar Index} = \frac{\text{Length of ala}}{\text{Transverse diameter of body of } S1} \times 100 \]

RESULTS AND DISCUSSION

The values obtained were tabulated and interpreted for the study of identification of the sex of the
sacrum. The data obtained was statistically analysed using the values in the available literature. Average sacral length was significantly greater in males (110mm) than females (94mm). The difference between average sacral breadths was not significant. (Males-104mm, Females-103mm). Average sacral index in females (109) was significantly greater than males (94). As per the present study, sacral index can reliably identify 58% of male sacrum and 42% of female sacrum. In general, the female sacral bone is broader, whereas, the male sacral bone is narrower. And also, it is observed that there is variation in sacral index in different regions of the country. Thus, sacral index helps in identifying the course of evolution in the human race and also, indicates the differences in sexual dimorphism among different age groups in different regions and sometimes, among different races.

The average sacral index in male (94) is same as (93.69) studied by Arora et al. (2010) in Amritsar region and was lower than that Amritsar region (100.24) studied by Sachdeva et al. (2011), Varanasi region (100.85) studied by Raju et al. (1981) and White people (106.49), Black (106.17) (Flander, 1978).

The average sacral index in female(109) is significantly same as that of White people (108.49) studied by Flander LB, 1978, Varanasi region (111.39) studied by Raju et al. (1981), Agra region (111.74) studied by Sachdeva et al. (2011), Agra region (117.84) studied by Mishra et al. (2003) and was lower than that of Davivongs (1963) (115.49) and Amritsar region (125.35) studied by Arora et al. (2010).

CONCLUSIONS

It is evident from present study that sacral index alone can differentiate 58% of male sacrum and 42% of female sacral bones. The comparison with previous study shows that sacral index is more in females than males in different populations. Thus, regional and racial differences in sacrum along with sacral index can be useful for anatomical, medico-legal and anthropological purposes. It is therefore a quite reliable and significant criteria for sex determination of sacrum.

Conflict of Interest

None.

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REFERENCES

Arora, A., Gupta, P., Mahajan, S., Kapoor, S. 2010. Significance of sacral index in estimation of sex in sacra of cadavers in Punjab. Journal of Indian Acad Forensic Med, 32(2):104–107.

Cheng, J. S., Song, J. K. 2003. Anatomy of the sacrum. Neurosurgical Focus, 15(2):1–4.

Davivongs, V. 1963. The pelvic girdle of the Australian aborigine; Sex differences and sex determination. American Journal of Physical Anthropology, 21(4):443–455.

Flander, L. B. 1978. Univariate and multivariate methods for sexing the sacrum. American Journal of Physical Anthropology, 49(1):103–110.

Horan, F. 2009. Gray’s Anatomy: the anatomical basis of clinical practice. The Journal of Bone and Joint Surgery. British volume, 91-B(7):983–983.

Krishna, K. 2007. Anthropometry in Forensic Medicine and Forensic Science-Forensic Anthropometry. The Internet Journal of Forensic Science, 2(1):1–12.

Mishra, S. R., Singh, P. J., Agrawal, A. K., Gupta, R. 2003. Identification of Sex of Sacrum of Agra Region. Journal of Anat. Soc. India, 52(2):132–136.

Raju, P. B., Singh, S., Padmanabhan, R. 1981. Sex determination and sacrum. Journal of anatomical Society of India, 30:13–15.

Sachdeva, K., Singla, K., Kalsey, R., Sharma, G., G 2011. Role of Sacrum in Sexual Dimorphism-A Morphometric Study. J Indian Acad Forensic Med, 33(3):206–210.

Singh, S. 1968. Sexing of adult clavicles-verification and applicability of demarking points. J Ind Acad Forensic Sci, 7:20–30.