Original Research Article

Sacral index and its clinical importance in human dry sacral bones - Morphometric study

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ABSTRACT

Background: Sacral Index is the most important parameter in assessing the sexual dimorphism.

Materials and Methods: A total of 42 dry adult human sacral bones of known sex (19 – female sacra; 23- male sacra) collected from Anatomy Department, Santhiram Medical College, Nandyal. The sacral length measured from the promontory to the middle of antero-inferior margin of last sacral vertebra. The sacral breadth measured from the lateral most points of ale of sacrum. The sacral index (SI) is calculated and statistically analyzed.

Results: We noted the mean sacral index 101.142+2.148 in male sacra, and 103.668+2.271 in female sacra with significantly higher sacral index in female sacra than male sacra in the present study.

Conclusion: Our study acknowledges the importance of sacral index and its significance can be useful in sexual dimorphism.

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1. Introduction

In identification of sex, sacral bones are of greatest interest to the forensic experts and anthropologists.¹ The morphometric parameters of sacrum varies in different populations leads to variations in sacral index.²,³ The sacral length, sacral breadth, curved length of sacrum, first sacral vertebral dimensions, ala of sacrum length play a greater role in sex determination. The sacral index is one of the best parameter in identify the sex.³ The sacral index plays a significant role as sex determining parameter among populations observed in previous literature.⁴,⁵ Our study aimed to analyze the sacral index and its significance in sex determination.

2. Materials and Methods

A total of 42 dry adult human sacral bones of known sex (19 – female sacra; 23- male sacra) collected from Anatomy Department, Santhiram Medical College, Nandyal to measure the sacral index and its significance. The length and breadth of male and female sacra were measured separately using vernier calipers. The sacral length measured from the promontory to the middle of antero-inferior margin of last sacral vertebra (Figure 1). The sacral breadth measured from the lateral most points of ale of sacrum (Figure 2). The parametric values were statistically analyzed.

The sacral index (SI) is calculated by the following formula

Sacral Index (SI) = Sacral Breadth X 100
Sacral Length

3. Results

The sacral bones are collected and categorized based on their sex and considered for the current study (Figure 3). We noted the mean sacral length in male sacra was 96.739+1.912, and mean sacral breadth was 96.521+1.805. The mean sacral length in female sacra was 95.894+2.643 and mean sacral breadth was 99.842+3.287 in
### Table 1: Distribution of adult sacra and their sacral index

| S.No. | Sex | Parameters of Male Sacrum | Parameters of Female Sacrum |
|-------|-----|---------------------------|-----------------------------|
|       |     | Length (mm) | Breadth (mm) | Sacral Index | Length (mm) | Breadth (mm) | Sacral Index |
| 1     | Male | 97          | 98          | 101         | 1           | Female      | 98          | 103         | 105         |
| 2     | Male | 96          | 95          | 98.9        | 2           | Female      | 96          | 98          | 102         |
| 3     | Male | 96          | 98          | 102         | 3           | Female      | 96          | 98          | 102         |
| 4     | Male | 97          | 98          | 101         | 4           | Female      | 98          | 104         | 106.1       |
| 5     | Male | 98          | 96          | 97.9        | 5           | Female      | 96          | 98          | 102         |
| 6     | Male | 96          | 98          | 102         | 6           | Female      | 94          | 98          | 104.2       |
| 7     | Male | 98          | 98          | 100         | 7           | Female      | 98          | 103         | 97.9        |
| 8     | Male | 98          | 96          | 97.9        | 8           | Female      | 97          | 104         | 107.2       |
| 9     | Male | 96          | 101         | 105         | 9           | Female      | 96          | 102         | 106.2       |
| 10    | Male | 96          | 98          | 102         | 10          | Female      | 98          | 101         | 103         |
| 11    | Male | 98          | 98          | 100         | 11          | Female      | 96          | 98          | 102         |
| 12    | Male | 96          | 98          | 102         | 12          | Female      | 98          | 103         | 105.1       |
| 13    | Male | 97          | 101         | 105         | 13          | Female      | 98          | 101         | 103         |
| 14    | Male | 95          | 96          | 101         | 14          | Female      | 92          | 98          | 106.5       |
| 15    | Male | 98          | 96          | 97.9        | 15          | Female      | 95          | 98          | 103.1       |
| 16    | Male | 94          | 96          | 104         | 16          | Female      | 91          | 96          | 105.4       |
| 17    | Male | 92          | 94          | 102.1       | 17          | Female      | 97          | 101         | 104         |
| 18    | Male | 96          | 98          | 102         | 18          | Female      | 97          | 98          | 101         |
| 19    | Male | 98          | 98          | 100         | 19          | Female      | 98          | 102         | 104         |
| 20    | Male | 102         | 96          | 94.1        | Mean        | 95.894      | 99.842      | 104.1       |
| 21    | Male | 98          | 102         | 104         | Sd          | 2.643       | 3.287       | 2.271       |
| 22    | Male | 95          | 98          | 103         |             |             |             |             |
| 23    | Male | 98          | 103         | 105         |             |             |             |             |

### Table 2: Statistical analysis

| S. No. | Sex  | Length Mean+Sd | Breadth Mean+Sd | Sacral Index Mean+Sd |
|--------|------|----------------|-----------------|----------------------|
| 1      | Male | 96.739+1.912   | 96.521+1.805    | 101.142+2.148        |
| 2      | Female | 95.894+2.643   | 99.842+3.287    | 103.668+2.271        |

**Fig. 1:** The length (A-B) of the sacrum measured from the midline from antero-superior margin of the promontory to the middle of antero-inferior margin of last sacral vertebra. **Fig. 2:** The breadth (C-D) of the sacrum measured between the lateral most points of ala of sacrum.
the present study (Table 1). We noted the mean sacral index 101.142+2.148 in male sacra, and 103.668+2.771 in female sacra with significantly higher sacral index in female sacra than male sacra in this study (Table 2)

4. Discussion
The female sacral length is lower than length of male sacra. Greater length may be due to the incidence of six piece sacrum in male sacra. The sacral index and mean breadth were significantly higher in female sacra compared with male sacra in the present study. The results are in agreement with previous literature. In determination of sex, the veracity of sacral index is 95% and also there is a variation of sacral index populations due to difference in anthropometric parameters of the sacra. In this study, the sacral index of male and female are 101.1, 103.6 classified under medium sacra category (Hyplatycheiric category - Sacral Index from 100 to 105.9) according to previous literature. Sacral index in male sacra is much higher compared to Telangana Region and Punjab Region studies on sacral index. The female sacral index is much higher compared to Madhya Pradesh Region and Varanasi Region studies. The sacral index was higher in female sacra with significantly higher sacral index in female sacra in females affirms that sacral index varies in divergent populations.

5. Conclusion
Our study acknowledges the importance of sacral index and its significance can be useful in sexual dimorphism.

6. Source of Funding
None.

7. Conflict of Interest
None.

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References
1. Apoorva D, Patil GV, Kumar S, Thejeshwari, Javed S, Sheshgiri C, et al. A study on sacral index in Kerala population of south India. J Anatomical Soc India. 2015;6(4):1–36.
2. Singh H, Singh J, Bargotra RN. Sacral index as observed anthropometrically in the region of Jammu. J Anat Soc India. 1988;37:1–13.
3. Ravichandran D, Shanthi KC, Shankar K, Chandra H. A Study on Sacral Index in Tamil Nadu and Andhra Pradesh Population of Southern India. J Clin Diagn Res. 2013;7(9):1833–4.
4. Davivongs V. The pelvic girdle of the Australian aborigine: Sex differences and sex determination. Am J Phys Anthropol. 1963;21(4):443–55.
5. Singh S, Ganrade KC. Sexing of adult clavicle verification and applicability of demarking point. J Indian Acad Forensic Sci. 1968;7:20–30.
6. Mishra SR, Singh PJ, Agrawal AK, Gupta RN. Identification of sex of sacrum of Agra region. J Anat Soc Ind. 2003;52(3):132–168.
7. Sachdeva K, Singla RK, Kalsey G, Sharma G. Role of sacrum in sexual dimorphism - A morphometric study. J Indian Acad Forensic Med. 2011;33(3):206–216.
8. Mamatha H, Sandhya, Sushma RK, Suhani S, Kumar N. Significance of various sacral measurements in the determination of sex in South Indian population. Int J Cur Res Rev. 2012;04(20):112–8.
9. Kothpalaji J, Velichety S, Desai V, Zaneer R. Morphometric study of sexual dimorphism in adult sacra of South Indian population. Int J Biol Med Res. 2012;3(3):2076–81.
10. Patel MM, Gupta BD, Singel TC. Sexing of sacrum by sacral index and kimura’s base wing index. JIAFM. 2005;27(1):5–9.
11. Maddikunta V, Ravinder M. Morphometric study of sacrum in sex determination in Telengana region people. Int J Res Med Sci. 2014;2(1):164.
12. Arora AK, Gupta P, Mahajan S, Sonney SK. Significance of sacral index in estimation of sex in sacra of cadavers in Punjab. J Indian Acad Forensic Med. 2010;32(2):104–7.
13. Shailendra P, Manish N, Pradeep M, Chandra SW. A Study of Sacral Index and Its Interpretation in Sex Determination in Madhya Pradesh. J Indian Acad Forensic Med. 2014;36(2):146–9.
14. Singh SP, Singh S. Identification of sex from the humerus. Ind J Med Res. 1972;60:37.
15. Somesh MS, Sridevi HB, Murlimanju BV. An anatomical study of adult sacrum with its emphasis on its sexual dimorphism in south indian population. Int J Anat Res. 2015;3(4):1491–6.
16. Flander LB. Univariate and multivariate methods for sexing the sacrum. Am J Phys Anthropol. 1978;49(1):103–10.

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