# Morphometric analysis of human sacra

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**Abstract**
**Background:** Sacrum is formed by fusion of five sacral vertebrae and forms the caudal end of the vertebral column. Anatomists and anthropologists since long acknowledged the importance of sacrum in identifying the sex of a deceased person. Sexual dimorphic characters can be studied both morphologically and metrically. **Material and Methods:** The present study was performed at Department of Anatomy, S. R. T. R. Government Medical College, Ambajogai, Maharashtra on 50 (25 male and 25 female) adult human sacra of known sex. Following equipments used were Sliding verniercaliper, divider, steel Measuring Scale. Parameters studied were Maximum length of sacrum, Maximum breadth of sacrum, Sacral index. **Aims and Objective:** This study was conducted to determine sexual dimorphism of adult sacrum, to evaluate the most significant parameter in sexual dimorphism and also to compare and contrast the result of present study with previous studies. **Results and Conclusion:** Ventral straght length and sacral index was found to be highly significant with a p value of <0.0001.Maximum breadth was found to be not significant with a p value of <0.0566.From the present study we find out similarities and differences in the metrical values of different sacral parameters in males and females and also highlighted the best parameter which can be used for sexual dimorphism of sacrum.
**Key Words:** Morphometric, human sacra.

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## INTRODUCTION

Sacrum is formed by fusion of five sacral vertebrae and forms the caudal end of the vertebral column. The sacrum supports the erect spine, provides the strength and stability to the bony pelvis in transmitting body weight. The bones of body are the last to perish after death next only to the enamel of teeth. Determination of sex is an integral first step in the development of the biological profile in human osteology. Sex determination is necessary to make age, ancestry and stature estimations, as the sex's age differently, exhibit some degree of variation in ancestry related morphology and generally differ in height. (Kothapalli). Anatomists and anthropologists since long acknowledged the importance of sacrum in identifying the sex of a deceased person.

## MATERIALS AND METHODS

The present study was performed on 50 (25 male and 25 female) adult human sacra of known sex. All of them were dry and free from deformity and fully ossified. All the sacra were obtained from Department of Anatomy, S.R.T.R. Government Medical College, Ambajogai, Maharashtra Following equipments were used for measurement of various parameters.

1. Sliding vernier caliper
2. Divider
3. Steel Measuring Scale

Each sacrum was studied for different features of sexual dimorphism and sacral hiatus.

**Sexual dimorphism**

1. **Maximum length of sacrum (Ventral straight length)**: With the help of vernier calliper straight length measured between the distance from the middle of the anterosuperior margin of sacral promontory in the mid sagittal plane to the

middle of anteroinferior margin of the last sacral vertebra.

2. **Maximum breadth of sacrum:** With the help of vernier calliper maximum distance was noted by midpoint of left and right alae of sacrum.
3. **Sacral index:** Sacral Index for each sacrum was calculated as follows:

Sacral index = (sacral width / sacral ventral straight length) x 100. After completing measurements, they were tabulated and statistically analysed with the help of SPSS software. Mean, standard deviation, range, demarking points and percentage of identified bones calculated.

## RESULTS

At the first of study, each parameter were tabulated and statistically analyzed. Comparative graphs of male and female values were drawn which shows the zone of difference and overlapping between male and female values.

**The ventral straight length:** The ventral straight length was found to be having a mean of 104.73 in males and 92.64 in females. The demarking points for males was >110.94 and <86.91 in females.

This parameter was helpful in identification of 16.86% of bones in males and 19.30% of bones in females. Ventralstraght length was found to be highly significant with a p value of <0.0001
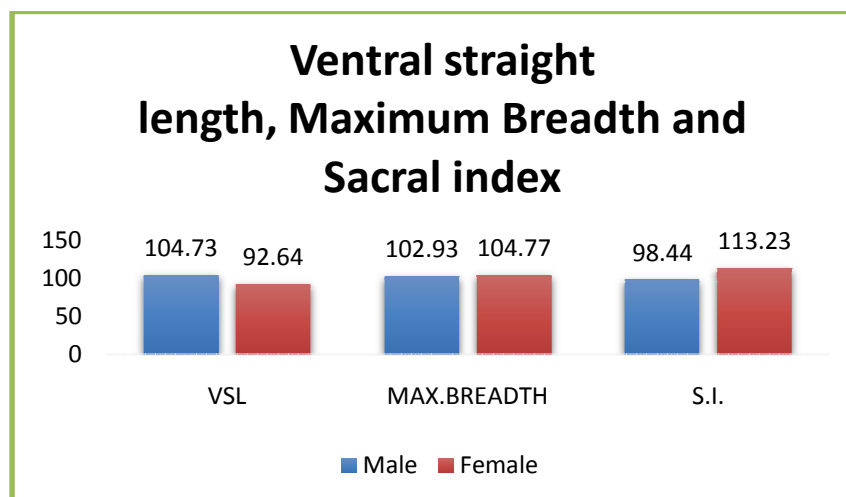
**The maximum breadth:** The maximum breadth was found to be having a mean of 102.93 mm in males and 104.77 mm in females. The demarking points for males was >124.21 and <88.44 in females.

Maximum breadth was found to be not significant with a p value of <0.0566.

**Sacral Index:** The sacral index was found to be having a mean of 98.44 mm in males and 113.23 mm in females. The demarking points for males was <96.4 and >112.51 in females. This parameter was helpful in identification of 27.71% of bones in males and 57.9% of bones in females. Sacral index was found to be highly significant with a p value of <0.0001.

**Table 1:** Showing measurements of Ventral straight length, Maximum breadthand sacral index in males and females

| | Ventral straight length | | Maximum breadth | | Sacral Index | |
|---|---|---|---|---|---|---|
| | **Male** | **Female** | **Male** | **Female** | **Male** | **Female** |
| No. of bone | 25 | 25 | 25 | 25 | 25 | 25 |
| sRange | 90.35 – 120.78 | 81- 110.64 | 92.65-115.65 | 88.98 – 126.54 | 86.78 to 116.09 | 99.13 to 123.10 |
| Mean | 104.73 | 92.64 | 102.93 | 104.77 | 98.44 | 113.23 |
| Standard deviation (S.D.) | 5.94 | 6.1 | 4.83 | 6.48 | 4.69 | 5.61 |
| Mean ± 3 S.D. | 86.91 – 122.55 | 74.34 – 110.94 | 88.44 – 117.42 | 85.33 – 124.21 | 84.37 to 112.51 | 96.4 to 130.06 |
| Demarking points | >110.94 | <86.91 | >124.21 | <88.44 | <96.4 | >112.51 |
| Percentage of bone identified | 16.86 | 19.3 | - | - | 22.17 | 57.9 |
| t value | 11.71 | | 1.923 | | 16.93 | |
| p value | < 0.0001 (H.S.) | | < 0.0566 (N.S.) | | < 0.0001 (H.S.) | |



**Ventral straight length, Maximum Breadth and Sacral index**

VSL: Male 104.73, Female 92.64
MAX.BREADTH: Male 102.93, Female 104.77
S.I.: Male 98.44, Female 113.23

■ Male   ■ Female

**Figure 1:** Showing measurements of all three parameters

# DISCUSSION

**Table 2:** Ventral Straight Length

| Sr. No. | INVESTIGATORS | MALE | | | | FEMALE | | | | SSD |
|---|---|---|---|---|---|---|---|---|---|---|
| | | N | X | RANGE | S.D. | N | X | RANGE | S.D. | P |
| 1 | Arora *et al* -2010 | 40 | 109.74 | - | 11.66 | 40 | 91.22 | - | 6.348 | <0.0001 |
| 2 | Shailaja *et al* -2010 | 190 | 11 | 8.2-13.3 | 0.84 | 64 | 9.45 | 8.2-11.1 | 0.85 | <0.001 |
| 3 | Sachdeva -2011 | 40 | 10.41 | 6.82-13.12 | 1.26 | 10 | 9.18 | 8.31-10.70 | 0.71 | <0.005 |
| 4 | Mazumdar *et al* (2012) | 127 | 100.8 | 66.3-135.3 | 11.5 | 123 | 87.3 | 65.1 – 109.5 | 7.4 | <0.001 |
| 5 | Present study | 25 | 104.73 | 90.35-120.78 | 5.94 | 25 | 92.64 | 81-110.64 | 6.1 | <0.0001 |

N= Sample size, X= Mean, S.D.= Standard deviation, p= Probability, N.S.= Not significant, S.S.D= Statistically significant difference between two sexes

**Table 3:** Maximum breadth

| Sr. No. | INVESTIGATORS | MALE | | | | FEMALE | | | | SSD |
|---|---|---|---|---|---|---|---|---|---|---|
| | | N | X | RANGE | S.D. | N | X | RANGE | S.D. | P |
| 1 | Shailaja *et al* -2010 | 190 | 10.42 | 6.5-14.2 | 0.9 | 64 | 10.6 | 9.2-12.1 | 0.691 | N.S. |
| 2 | Arora *et al* -2010 | 40 | 101.94 | | 8.96 | 40 | 114.13 | | 9.67 | <0.0002 |
| 3 | Sachdeva -2011 | 40 | 10.31 | 8.70-11.90 | 0.78 | 10 | 10.17 | 9.50-11.80 | 0.7 | N.S. |
| 4 | Mazumdar *et al*(2012) | 127 | 96.3 | 74.1 -118.5 | 7.4 | 123 | 95.6 | 78.5 -112.7 | 5.7 | N.S. |
| 5 | Present study | 25 | 102.93 | 92.65-115.65 | 4.83 | 25 | 104.77 | 88.98- 16.54 | 6.48 | N.S. |

**Table 4:** Sacral Index

| Sr. No. | INVESTIGATORS | MALE | | | | FEMALE | | | | SSD |
|---|---|---|---|---|---|---|---|---|---|---|
| | | N | X | RANGE | S.D. | N | X | RANGE | S.D. | P |
| 1 | Shailaja C Math (2010) | 190 | 94.24 | 53.57-152 | 11.78 | 64 | 113.19 | 91.89-146.15 | 10.26 | <0.001 |
| 2 | Arora *et al* -2010 | 20 | 93.69 | 58.9-128.38 | 11.57 | 20 | 125.35 | 90.94-159.76 | 11.47 | <0.0001 |
| 3 | Sachdeva -2011 | | 100.24 | 78.04-149.56 | 12.54 | | 111.14 | 88.79-140.48 | 14.6 | <0.016 |
| 4 | Mazumdar*et al* (2012) | 127 | 94.9 | 80.5-109.3 | 4.8 | 123 | 109.8 | 87.9-131.7 | 7.3 | <0.0001 |
| 5 | Present study | 25 | 98.44 | 86.78-116.09 | 4.69 | 25 | 113.23 | 99.13-123.1 | 5.61 | <0.0001 |

Various studies of different authors were compared with present study for all three parameters are shown in Table 2,3 and 4.

## CONCLUSION

The mean value for ventral straight length was found to be104.73 mm in males and 92.64 mm in females and was statistically highly significant. The study is correlated with Raju *et al* and Sachdeva *et al*. The mean value for maximum breadth found to be 102.93 mm in males and 104.77 mm in females and was statistically not significant. 0% of bones were identified by using this parameter. The findings of present study correlated with study done by Raju *et al* and Sachdeva *et al*. The mean value for sacral index found to be 98.44 mm in males and 113.23 mm in females. 57.9% of bones in females and 27.71% of bones in males were identified by using this parameter. This is most significant parameter for sex determination. Similar findings were reported by other research workers such as Mishra *et al*, Shailaja *et al*, Patel. Anatomists and anthropologists since long acknowledged the importance of sacrum in identifying the sex of a deceased person. The present study was undertaken to find out similarities and differences in the

metrical values of different sacral parameters in males and females and also highlight the best parameter which can be used for sexual dimorphism of sacrum.

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