



## Morphometric Study of Human Sacrum

Published online on 29<sup>th</sup> June 2017@www.eternalpublication.com

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Received: 13<sup>th</sup> June 2017; Accepted: 20<sup>th</sup> June 2017

**How to cite this article:** Shingare AK, Masram NB, Dhapate SS. Morphometric study of human sacrum. International Journal of Anatomy Physiology and Biochemistry 2017;4(6):1-4.

### Abstract:

**INTRODUCTION:** Sacrum is a large triangular bone forming the posterosuperior wall of the pelvic cavity wedged between the two innominate bones. It 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.

**MATERIALS & 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 sacrum of known sex. Equipments used were Sliding vernier caliper, divider and steel measuring scale. Parameters studied were Maximum length of sacrum, Maximum breadth of sacrum, Sacral index.

**AIMS & OBJECTIVES:** 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 straight 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.

**Keywords:** sacral index, sacrum, sexual dimorphism

### Introduction:

Sacrum is a large triangular bone forming the posterosuperior wall of the pelvic cavity wedged between the two innominate bones. It 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.<sup>1,2</sup>

Anatomists and anthropologists since long acknowledged the importance of sacrum in identifying the sex of a deceased person. So aims and objectives of the present study was to study

sexual dimorphism of adult sacrum, to evaluate the most significant parameter in sexual dimorphism and to compare and contrast the result of present study with previous studies.

### Materials & 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 sacrum was 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 studied:

1. **Maximum length of sacrum (Ventral straight length):** With the help of vernier caliper 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 caliper 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 analyzed with the help of SPSS software. Mean, standard deviation, range, demarking points and percentage of identified bones calculated.

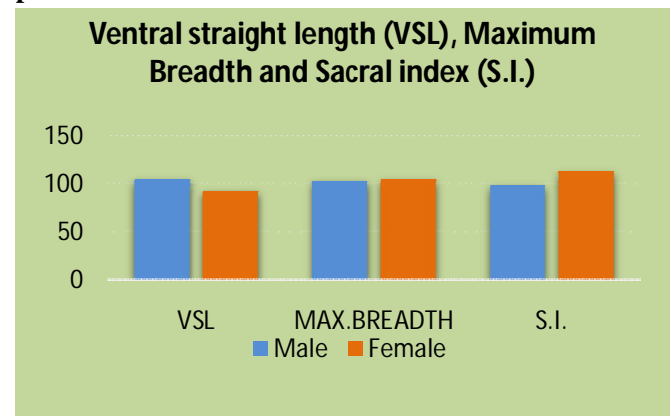
### Results:

**Table 1 showing measurements of Ventral straight length, Maximum breadth & 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
Range	90.35 to 120.78	81 to 110.64	92.65 to 115.65	88.98 to 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 (SD)	5.94	6.1	4.83	6.48	4.69	5.61
Mean $\pm$ 3 S.D.	86.91 to 122.55	74.34 to 110.94	88.44 to 117.42	85.33 to 124.21	84.3 to 112.51	96.4 to 130.06
Demarking points	>110.94	<86.91	>124.21	<88.44	<96.4	>112.51
% 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.)	

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.

**Graph 1: Showing measurements of all three parameters.**



**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. Ventral straight 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.

**Discussion:**

**Table 2: Comparison of Ventral straight length among different studies**

Investigators	MALE				FEMALE				SSD
	N	X	Range	SD	N	X	Range	SD	P
Arora AK et al <sup>3</sup> (2010)	40	109.74	-	11.66	40	91.22	-	6.348	<0.001
Math SC et al <sup>4</sup> (2010)	190	111	8.2 to 13.3	0.84	64	94.5	8.2 to 11.1	0.85	<0.001
Sachdeva K et al <sup>5</sup> (2011)	40	104.41	6.82 to 13.12	1.26	10	91.8	8.31 to 10.70	0.71	<0.005
Mazumdar S et al <sup>6</sup> (2012)	127	100.8	66.3 to 135.3	11.5	123	87.3	65.1 to 109.5	7.4	<0.001
Present study	25	104.73	90.35 to 120.78	5.94	25	92.64	81 to 110.64	6.1	<0.001

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: Comparison of maximum breadth among different studies**

Investigators	Male				Female				SSD
	N	X	Range	S. D.	N	X	Range	S. D.	P
Math SC et al <sup>4</sup> (2010)	190	104.2	6.5 to 14.2	0.9	64	106	9.2 to 12.1	0.691	N.S.
Arora AK et al <sup>3</sup> (2010)	40	101.94	-	8.96	40	114.13	-	9.67	<0.002
Sachdeva K <sup>5</sup> (2011)	40	103.1	8.70 to 11.90	0.78	10	101.7	9.50 to 11.80	0.7	N.S.
Mazumdar S <sup>6</sup> et al (2012)	127	96.3	74.1 to 118.5	7.4	123	95.6	78.5 to 112.7	5.7	N.S.
Present study	25	102.93	92.65 to 115.65	4.83	25	104.77	88.98 to 126.54	6.48	N.S.

**Table 4: Comparison of Sacral Index among different studies**

Investigators	Male				Female				SSD
	N	X	Range	SD	N	X	Range	SD	P
Math SC et al <sup>4</sup> (2010)	190	94.24	53.57 to 152	11.78	64	113.19	91.89 to 146.15	10.26	<0.001
Arora AK et al <sup>3</sup> (2010)	20	93.69	58.9 to 128.38	11.57	20	125.35	90.94 to 159.76	11.47	<0.001
Sachdeva K et al <sup>5</sup> (2011)	-	100.24	78.04 to 149.56	12.54	-	111.14	88.79 to 140.48	14.6	<0.016
Mazumdar S et al <sup>6</sup> (2012)	127	94.9	80.5 to 109.3	4.8	123	109.8	87.9 to 131.7	7.3	<0.001
Present study	25	98.44	86.78 to 116.09	4.69	25	113.23	99.13 to 123.1	5.61	<0.001

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

The mean value for ventral straight length was found to be 104.73 mm in males and 92.64 mm in females and was statistically highly significant.

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 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.

### Conclusion:

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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