

# Sexual Dimorphism of Sacrum by its Morphometric Analysis in Southern Punjab Pakistan

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## ABSTRACT

**Objective:** To determine the Sexual Dimorphism of Sacrum in Southern Punjab Pakistan.

**Study Design:** Observational study

**Place and Duration of Study:** This study was conducted at the Quaid-a-Azam Medical College, Bahawalpur and Sheikh Zayed Medical College, Rahim Yar Khan during June 2016 to December 2016.

**Materials and Methods:** The measurement has been taken from median straight and curved line longitudinally and transversally on ventral side. First sacral body's transverse diameter, base, antero-posterior diameter and breadth of alae were measured. The curvature index of longitudinal measurement and index of corporobasal areas were measured and analyses were done statistically.

**Results:** Mid ventral straight measurement, curved length of midventral areas, transverse base diameter, diameter of antero-posterior side of first sacral vertebra and alae's breadth were more significant in males while index of sacrum was more significant in females. Index of corporobasal area was found more and insignificant in females statistically.

**Conclusion:** Functional differences of sacrum are present both in male and female in the pelvic girdle that's why for identification it is important in both sexes in the human.

**Key Words:** Sexual Dimorphism, Sacrum, Sacral Parameters, Corporobasal Index, Sacral Index

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## INTRODUCTION

Correct assessment of gender from an unidentified skeleton of human-being may be a difficult assessment when remains of incomplete human skeleton are found. Five sacral vertebrae are fused and form a single triangular sacral body which is taking part for the formation of postero superior wall of pelvic cavity. These vertebra are present at the middle hip bones.<sup>1,2</sup> Spinal axis is counted from sacrum by Neuroradiologist whereas radiologist of cross-section of abdomen see the sacrum as a bone forming pelvic posterior border.<sup>3</sup> In males and females sacrum is diamorphically different.<sup>4,5</sup> Methods of non-metric type are available with what sex can be estimated from the sacrum, but these methods are unclear and unproven. In the male the sacrum is longer and less wider than in female; the greater angle is formed in the lower half than the upper; the upper half is nearly straight, the amount is greatest in curvature in lower half.

The bone is also directed more obliquely backward; this increases the size of the pelvic cavity and renders the sacrovertebral angle more prominent.

In the male, the curvature is more evenly distributed over the whole length of the bone, and is altogether larger than in the female. Anatomists has deep interest in sacrum, medico-legal experts and anthropologists for establishing its sex, because it has a pivot role for the formation of pelvic girdle where it has a different function in male and female.<sup>6</sup> Thus sacrum assumes an applied importance in determining sex with the help of measurements carried upon it.<sup>7</sup>

Sacrum is an important bone both in male and female for making the pelvic cavity while it is more important in females for bearing the brunt of pregnancy.<sup>8</sup> A data for making the base line in Southern Punjab, has been added in the existing literature for sexual diamorphism in sacrum.

## MATERIALS AND METHODS

This study was conducted in the Department of Anatomy at Shahida Islam Medical College, Lodharan, Sheikh Zayed Medical College, Rahim Yar Khan and Quaid-e-Azam Medical College, Bahawalpur during the period June, 2016 to December, 2016. Fifty adult sacral bones were collected from the anatomy department of above mentioned medical colleges. The bones having fracture, wear & tear or showing any sign of pathology were excluded from the study. Vernier calipers was

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used for linear measurement and the measuring tape was used for curved distances. Table one is showing the parameters related to sacrum, measured in this study. In these measurements, three indices were calculated for the sacra which are given in the In Table 2 three indices were given after measuring and calculating from sacra of male and female.

The two subsamples were made from original sample, the 10 females and 40 males respectively. The measurements are mentioned in table one. The indices were calculated and put in to table two. The measurements obtained was checked, tabulated, analysed statistically, using maximum and minimum values, means deviation from standard and confidence value 95% interval of mean. Student’s t test (independent) was applied and significant differences were calculated for the two samples.

**RESULTS**

The mean ± SD of mid ventral straight length (cm) in male sacrum is 10.41±1.26 while in female is 9.18±0.71 and P value 0.005 which is significant. The mid ventral curved length in male sacrum is 11.35±1.06 while in female is 10.45±0.62 and P value is 0.013 which is

significant. The ventral straight breadth in centimeter in male sacrum is 10.31±0.78 while in female is 10.17±0.70, has P value as 0.612 which is insignificant. The transverse diameter of base in male sacrum is 11.18±0.84 while in female is 10.44±0.78, having P value is 0.015 which is significant. The transverse diameter of 1<sup>st</sup> sacral vertebra in male is 4.76±0.71 while in female is 4.55±0.48 having P value is 0.380 which is insignificant. The antero posterior diameter of S1 In male is 3.15±0.41 while in female is 2.85±0.23 with the P value 0.033 which is significant. In male the breadth of alae is 3.35±0.37 while in female is 3.00±0.43 having P value <0.001 which is highly significant. Sacral index percentage in male is 100.24±12.54 while in female is 111.74±14.6 shows P value as 0.016 which is quite significant. In male the longitudinal curvature index is 91.59±6.43 while in female is 87.87±5.67, having P value 0.101 which is insignificant. The corporobasal index percentage in male is 43.22±4.28 while in female is 43.84±5.44, having P value is 0.598 as shown in Table-03. The P values of all the parameters are significant except ventral straight breadth, transverse diameter of 1<sup>st</sup> sacral vertebra as is given in Table-3.

**Table No.1: Various sacral parameters of the study**

Sr. No.	Parameter (cm)	Method	Shown in Fig.1
1.	Midventral Straight Length [2]	The midpoint of the sacral promontory to the middle of anteroinferior border of the fifth sacral vertebra	AB
2.	Midventral Curved Length	Length of the curved median line drawn along ventral surface from the middle of sacral promontory to midpoint of anteroinferior border of 5th sacral vertebra	AB dotted
3.	Ventral Straight breadth [7]	Straight distance across the ventral surface of the first sacral vertebra between the widest margins of lateral wings	CD thick line
4.	Transverse Diameter Base	Maximum transverse width of the superior surface of sacrum, comprising the two alae	EF
5.	Transverse Diameter Body S1 [8]	Maximum transverse diameter of the articular surface of the body of first sacral vertebra	E’F’
6.	AP Diameter Body S1 [3]	Anteroposterior distance from the midpoint of sacral promontory up to the mid-point on the posterior border of body of S1	AL
7.	Breadth of Alae	Straight distance of the ala of the sacrum from the transverse diameter of the body of first sacral vertebra	EE’ & FF’

**Table No.2: Defining various indices of sacrum studied**

Sr. No.	Index	Calculated as
1.	Sacral Index	$= \frac{\text{Anterior straight breadth of sacrum (Sr. No. 3)}}{\text{Midventral straight length of sacrum (Sr. No. 1)}} \times 100$
2.	Longitudinal curvature index	$= \frac{\text{Midventral straight length of sacrum (Sr. No. 1)}}{\text{Midventral curved length of sacrum (Sr. No. 2)}} \times 100$
3.	Corporobasal index	$= \frac{\text{Corpus width of S1 (Sr. No. 5)}}{\text{Breadth of base of sacrum (upper surface) (Sr. No. 4)}} \times 100$

**Table No.3: Results of sacral parameters in the present study and their statistical evaluation**

Sr. No.	Parameter	Sex	Mean + S.D.	Range	95% CI	P-value
1.	Mid ventral Straight Length (cm)	M	10.41+1.26	6.82-13.12	10.01-10.80	0.005*
		F	9.18+0.71	8.31-10.70	8.73-9.62	
2.	Mid ventral Curved Length(cm)	M	11.35+1.06	9.60-14.10	11.02-11.68	0.013*
		F	10.45+0.62	9.80-11.60	10.07-10.83	
3.	Ventral Straight breadth(cm)	M	10.31+0.78	8.70-11.90	10.07-10.55	0.612
		F	10.17+0.70	9.50-11.80	9.73-10.61	
4.	Transverse Diameter Base(cm)	M	11.18+0.84	9.70-13.60	10.92-11.44	0.015*
		F	10.44+0.78	9.50-11.90	9.95-10.92	
5.	Transverse Diameter Body S1(cm)	M	4.76+0.71	1.40-6.50	4.54-4.99	0.380
		F	4.55+0.48	3.90-5.50	4.26-4.85	
6.	AP Diameter Body S1(cm)	M	3.15+0.41	2.40-4.41	3.02-3.28	0.033*
		F	2.85+0.23	2.60-3.28	2.71-2.99	
7.	Breadth of Alae (cm)	M	3.35+0.37	2.57-4.20	3.24-3.46	<0.001**
		F	3.00+0.43	2.58-4.00	2.74-3.27	
8.	Sacral Index (%)	M	100.24+12.54	78.04-149.56	96.36-104.1	0.016*
		F	111.74+14.6	88.79-140.48	102.65-120.84	
9.	Longitudinal Curvature Index (%)	M	91.59+6.43	71.04-112.26	89.59-93.58	0.101
		F	87.87+5.67	80.43-98.12	84.36-91.38	
10.	Corporobasal Index (%)	M	43.22+4.28	32.87-54.81	41.89-44.55	0.598
		F	43.84+5.44	32.77-52.38	40.47-47.21	

Abbreviations: CI- Confidence Interval, S.D.-Standard Deviation, St.- Straight,S1- First Sacral Vertebra, p-value-Significance by Students T-Test,\*- Significant, \*\*- Highly significant

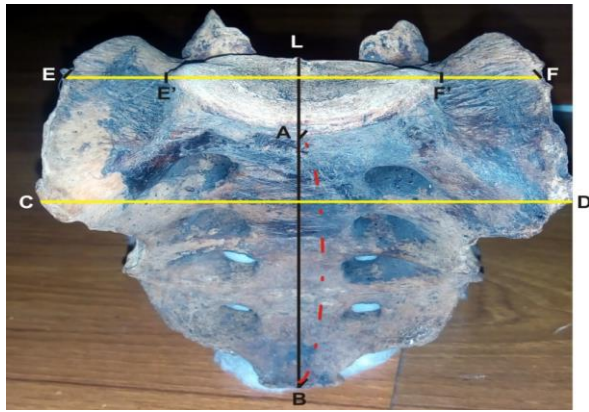
**Table No.4: Comparison of Sacral parameters amongst different population groups**

Author(Year) Population	Davivongs (1963) Australian Aborigines		Raju et al (1980) Varanasi		Mishra et al (2003) Agra		Ubi Essein et al (2014) Nigeria		Present Study 2015	
	M (50)	F (50)	M (33)	F (11)	M (74)	F (42)	M(50)	F(50)	M (40)	F (10)
1.Mid ventral Straight Length(cm)	9.65	8.81	10.50	9.27	10.75	9.06	11.41	9.18	10.41	9.18
2.Mid ventral Curved Length(cm)	10.43	9.71	11.28	10.48	11.96	10.95	12.35	10.95	11.35	10.45
3.Ventral Straight breadth (cm)	9.99	10.12	-	-	10.53	10.58	11.31	11.17	10.31	10.17
4.Transverse Diameter Base(cm)	-	-	10.53	10.35	-	-	11.38	10.49	11.18	10.44
5.Transverse Diameter Body S1(cm)	4.74	4.41	4.73	4.21	4.91	4.28	6.76	4.55	4.76	4.55
6.AP Diameter Body S1(cm)	2.98	2.76	3.03	2.76	3.00	2.93	4.15	2.85	3.15	2.85
7. Breadth of Alae (cm)	-	-	-	-	2.89	3.17	3.75	3.00	3.35	3.00
8.Sacral Index (%)	104.16	115.49	100.85	111.39	98.21	117.84	100.24	110.74	100.24	111.74
9.Longitudinal Curvature Index (%)	92.46	90.80	92.77	88.51	95.72	90.72	91.59	87.87	91.59	87.87
10.Corporobasal Index (%)	47.42	43.62	44.94	40.96	46.54	40.47	43.42	43.84	43.42	43.84

**DISCUSSION**

Many studies are present for reliable sex estimation on the basis of quantitative assessment for sexual dimorphic traits of the sacrum.<sup>9</sup> Pelvic girdle is formed by sacrum, sex can be estimated by this portion due to its location and size differences as by its diameter, length and width in both male and female sex. Lesser degree of curvatures are present in case of female due

to accommodation of child in uterus and large inlet of the female pelvis.<sup>8</sup> The angle of curvature at different points along the entire anterior surface, breadths and lengths of sacrum are measured. Straight breadth of anterior surface of first sacral vertebra is most dependable measurement for diamorphic sexual trait.<sup>9</sup> The measurement of maximum sacral breadth creates doubtful reliability of sexual variation in detecting sexual diamorphism in male and female.<sup>10</sup>



**Figure No.1: Measurements in cm of sacrum. L A- Anteroposterior diameter of body of S1, A-B(Black line): Mid ventral straight length, A-B(Red dotted line): Mid central curved length, E-F(Black line): Transverse diameter of S1, E-F(Yellow line): Transverse diameter of base, C-D(Yellow line): Breath of ala**



**Figure No.2: Shows sacral index and longitudinal curvature index**

In male and female the sacrum has different functions in pelvic girdle that's why it has its own importance in both sexes to perform its functions. For sacral identification in male and female, seven parameters are obtained, five parameters giving significant mean differences. These were Mid ventral straight length, Mid ventral curved length, diameter of antero-posterior surface of first Sacral vertebra and ala's breadth, basal transverse diameter of base; all being less in the females and more in males. The present work is the same as has been proved previously while opposite results were obtained in case of ala's breadth and coroprobasal index.<sup>11,12,13</sup> In case of males, the wide ala's were present while in females the index of coroprobasal is more.

## CONCLUSION

Functional differences of sacrum are present both in male and female in the pelvic girdle that's why for identification it is important in both sexes in the human. In this study, five parameters are significant in mean differences between male and female sexes while just

two are insignificant. These were mid ventral straight length, this is the first parameter, in second parameter the mid ventral length is curved, basal diameter transversely, ala's breadth and diameter of first sacral vertebra anterior to posterior; all these parameters are increased in males and decreased in females. In females the sacral indices are more significant.

### Author's Contribution:

Concept & Design of Study: Mujahid Akbar Mamoun  
 Drafting: Asad Bilal Arif  
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 Revisiting Critically: Asad Bilal Arif  
 Final Approval of version: Mujahid Akbar Mamoun

**Conflict of Interest:** The study has no conflict of interest to declare by any author.

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