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**A MORPHOMETRIC STUDY TO DEMONSTRATE THE DIFFERENCES BETWEEN  
A MALE AND FEMALE SACRUM BASED ON THE MEASUREMENTS OF ADULT  
HUMAN SACRA**

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**Abstract**

**Objective:** To study the differences between a male and female sacrum based on the measurements of an adult human sacra.

**Methods:** The present study is comprised of 120 dry and clean adult human sacra of known sex but of unknown age. The sacra were collected from Department of Anatomy of various Medical Institutes in Maharashtra.

**Results:** From the present study the Mid Ventral Straight Length, Mid Ventral Curved Length, Transverse Diameter of Body of 1<sup>st</sup> Sacral Vertebra, Antero-Posterior Diameter of Body of 1<sup>st</sup> Sacral Vertebra, Length of Right and Left Ala of Sacrum, Mean Length of Ala of Sacrum, Weight of Sacrum, showed statistically highly significant difference between the means of male and female sacra.

**Conclusion:** The following parameters - Antero-Posterior Diameter of Body of 1<sup>st</sup> Sacral Vertebra, Transverse Diameter of Body of 1<sup>st</sup> Sacral Vertebra, Mid Ventral Curved Length, Weight of Sacrum, Mid Ventral Straight Length, Mean Length of Ala, Length of Left Ala and Right Ala of Sacrum are found to be more accurate in sexing the sacra depending upon the percentage of identified bones by demarking point. Thus they will help in sexing the unknown samples of sacra.

**Keywords:** adult human sacra, Mid Ventral Curved Length, Weight of Sacrum, Mid Ventral Straight Length, Mean Length of Ala, Length of Left Ala

## INTRODUCTION

The bones of the body are the last to perish after death, next to the enamel of teeth. Hence, in establishing the personal identity with respect to sex, age and stature, Anatomist and Anthropologist use the skeletal material for giving their opinion <sup>[1]</sup>. Sex determination from bones is of vital importance in anthropological studies and medico-legal cases. The role of skeleton is invaluable in estimating attributes such as age, sex, race, stature and presence of disease. If the whole skeleton is available, there should be no difficulty in arriving at an accurate diagnosis of sex, but when only a part of the skeleton is available, it poses increasing difficulty in assessment.

Almost all bones of the human skeleton show some degree of sexual dimorphism. The accuracy of sex determination depends on the type and condition of the bone, age of the subject, the degree of fragmentation of the bones and biological variability. Obvious sex differences do not become apparent until after puberty, though specialized measurements on the pelvis can indicate sex even in fetal material <sup>[2]</sup>.

The sacrum is a large triangular bone formed by fusion of five vertebrae and forms the postero-superior wall of the pelvic cavity, wedged between the two innominate bones. The sacrum (L-sacer- sacred) supports the erect spine, provides the strength and stability of the bony pelvis to transmit the body weight and also allows considerable mobility in childbearing. Sex determination of skeletal material is of concern to anatomists, anthropologists, paleoanthropologists, paleodemographers and forensic scientists. Sexual dimorphic characters can be studied both morphologically and metrically. In the determination of personal individuality from adult human skeletal remains, the pelvis affords the best marked and reliable characteristics for distinguishing sex in legal experts for establishing sex in 90% - 95% subjects. The sacrum has always enjoyed the attention of medico-legal experts for establishing the sex due to its contribution to the pelvic girdle and associated sex differences which are augmented due to reproductive functions, mainly influenced by sex hormones. The female sacra are shorter and wider, providing a wider pelvic cavity <sup>[3]</sup>

## MATERIALS AND METHODS

The present study is comprised of 120 dry and clean adult human sacra of known sex but of unknown age. Complete developed sacrum without any deformity, fracture or damage were included while those of unknown sex, broken or those showing any fracture and pathological wear and tear were excluded from this study. The sacra were collected from Department of Anatomy of various Medical Institutes in Maharashtra.

### **INSTRUMENTS USED FOR STUDY :-**

- I. Sliding vernier calliper (Fig.3)
- II. Measuring tape (Fig.3)
- III. Digital Weighing machine (Fig.4)
- IV. Measuring scale (Fig. 3)

With the help of these instruments following parameters were measured on individual sacrum : -

1. **Mid-ventral Straight Length** <sup>[4]</sup>:- It is measured from the midpoint of the sacral promontory to the middle of the antero-inferior border of the 5<sup>th</sup> sacral vertebra.
2. **Mid-ventral Curved Length** <sup>[4]</sup>:- It is the length of the curved median line drawn along ventral surface from the middle of sacral promontory to midpoint of antero-inferior border of 5<sup>th</sup> sacral vertebra.
3. **Transverse Diameter of Base** <sup>[4]</sup> / **Total width of sacrum** <sup>[3]</sup> :- It is the maximum transverse width of the superior surface of sacrum, comprising the two alae.
4. **Ventral Straight Breadth**<sup>[4]</sup> :- It is the straight distance across the ventral / anterior surface of the 1<sup>st</sup> sacral vertebra between the widest margins of lateral wings.
5. **Transverse Diameter of Body of S1 vertebra** <sup>[4]</sup> :- It is the maximum transverse diameter of the articular surface of the body of 1<sup>st</sup> sacral vertebra.
6. **Antero-posterior Diameter of Body of S1 vertebra** <sup>[4]</sup> :- It is the antero-posterior distance from the mid-point of sacral promontory up to the mid-point on the posterior border of body of S1 vertebra.
7. **Length of ala** <sup>[5]</sup>:- It is the straight distance of the ala of the sacrum from the transverse diameter of the body of 1<sup>st</sup> sacral vertebra (breadth of ala) <sup>[4]</sup>. It is measured on both the sides by taking one point on lateral most point of superior surface of body of 1<sup>st</sup> sacral body and another point on lateral most point of ala (width of wing/ ala) <sup>[6]</sup>. The mean of the length of two sides is taken as the length of ala of that vertebra for calculating the alar index <sup>[5]</sup>. While, the width of right and left ala were taken separately for calculating the Kimura's Base-Wing Index for right and left wing (ala) of sacrum <sup>[6]</sup>.
8. **Extent of sacral hiatus** :- It is noted from below upwards where the apex of sacral hiatus is located.
9. **Weight of sacrum** :- It is measured in Grams by using digital weighing machine.

From the above metrical data following details were obtained by using formulae. They were the range, mean, standard deviation (S.D.), 't' value and 'p' value by applying Unpaired 't' test, Identification Point, calculated range, Demarking Point and percentage of bones in which sex could be identified by demarking point for each parameter. The 'p' value <0.0001 is considered to be statistically highly significant while >0.05 is considered to be statistically not significant.

The calculated range was obtained by adding and subtracting (2 X standard deviation) to and from the mean value. The calculated range (mean  $\pm$  2SD) thus obtained will cover upto 95% confidence limit. From the obtained values, demarking points (DP) were calculated on the lines of Jit and Singh (1966) <sup>[7]</sup> and percentage of bones, thus identified were found out in relation to each parameter. Any single DP for any of the parameters, if crossed would detect the sex with 100% accuracy (Singh and Raju, 1977) <sup>[8]</sup>.

Thus for mid ventral straight length of sacrum, the calculated range for male is 8.472 to 11.848cm and for female is in between 7.768 to 11.636cm. thus the demarking point for ventral straight length of sacrum for males >11.636cm and for female is <8.472cm, it means that sacrum with mid ventral straight length measuring above 11.636cm is definitely a male and below 8.472cm is definitely a female.

Identification point (IP) is a limiting point of actual range of every measurable parameter in male and female.

Then each metrical parameter was tabulated in individual tables and graphs were plotted. Qualitative data was summarized in the form of proportions.

### RESULTS

**Table 1: Distribution of Mid Ventral Straight Length in Different Gender**

Sr. No.	Detailed measurements	Male	Female
<b>1</b>	<b>Distribution of straight length(cm)</b>	<b>No. of Sacra</b>	<b>No. of Sacra</b>
	8 – 9	2	13
	9 - 10	23	21
	10 - 11	29	13
	11 - 12	13	1
	12 -13	3	2
<b>2</b>	<b>Total No. Of bones</b>	70	50
<b>3</b>	<b>Range</b>	8.1 – 12.5	8.2 – 12.2
<b>4</b>	<b>Mean</b>	10.16	9.70
<b>5</b>	<b>SD</b>	0.84	0.97

<b>6</b>	<b>Identification point</b>	> 12.2	< 8.1
<b>7</b>	<b>Calculated Range</b>	8.47 – 11.85	7.77 – 11.64
<b>8</b>	<b>Demarking point</b>	> 11.64	< 8.47
<b>9</b>	<b>% of Identified bone</b>	11.42	8

**\*\* t value = 4.7 , p < 0.0001 (Highly significant)**

Table no.1 shows the study of mid ventral straight length of sacrum. The mean value for males is  $10.16 \pm 0.84$  cm and for females is  $9.70 \pm 0.97$  cm. The difference between genders is statistically highly significant. The range for male sacra is 8.1 - 12.5cm and for female sacra is 8.2 – 12.2cm. The Identification Point (IP) for male sacra is >12.2cm and that for female sacra is <8.1cm. The calculated range (mean  $\pm$  2 S.D.) for male sacra is 8.472 – 11.85cm and that for female sacra is 7.768 – 11.64cm. The Demarking Point (DP) for male sacra is >11.64cm and for female sacra is <8.47cm. From this demarking point 11.42% male and 8% female bones can be identified respectively. The same is represented graphically in the following graph 1.

**Table 2: Distribution of Mid Ventral Curved Length in different gender**

<b>Sr. No.</b>	<b>Detailed measurements</b>	<b>Male</b>	<b>Female</b>
<b>1</b>	<b>Distribution of Curved Length (cm)</b>	<b>No. of Sacra</b>	<b>No. of Sacra</b>
	9 - 10	3	16
	10 – 11	32	22
	11 - 12	22	8
	12 – 13	11	4
	13 - 14	2	0
<b>2</b>	<b>Total no. of bones</b>	70	50
<b>3</b>	<b>Range</b>	9 – 13.5	9 – 12.7
<b>4</b>	<b>Mean</b>	11.36	10.59
<b>5</b>	<b>SD</b>	0.91	0.92

<b>6</b>	<b>Identification point</b>	> 12.7	< 9
<b>7</b>	<b>Calculated Range</b>	9.55 – 13.17	8.74 – 12.44
<b>8</b>	<b>Demarking point</b>	> 12.44	< 9.55
<b>9</b>	<b>% of identified bone</b>	12.85	14

**\*\* t value= 4.5, p<0.0001 (Highly significant)**

Table no.2 shows the study of mid ventral curved length of sacrum. The mean value for males is  $11.36 \pm 0.91$  cm and for females is  $10.59 \pm 0.92$  cm. The difference between genders is statistically highly significant. The range for male sacra is 9- 13.5cm and for female sacra is 9 – 12.7cm. The Identification Point (IP) for male sacra is >12.7cm and that for female sacra is <9cm. The calculated range (mean  $\pm$  2 S.D.) for male sacra is 9.55 –13.17cm and that for female sacra is 8.74 –12.44cm. The Demarking Point (DP) for male sacra is >12.44cm and for female sacra is <9.55cm. From this demarking point 12.85% male and 14% female bones can be identified respectively.

**Table 3: Distribution of Ventral Straight Breadth in different gender**

<b>Sr. No.</b>	<b>Detailed measurements</b>	<b>Male</b>	<b>Female</b>
1	<b>Distribution of Ventral Straight Breadth (cm)</b>	<b>No. of Sacra</b>	<b>No. of Sacra</b>
	8 - 9	3	5
	9 - 10	32	18
	10 - 11	33	19
	11 - 12	2	7
	12 - 13	0	1
2	<b>Total no. of bones</b>	70	50
3	<b>Range</b>	8.3 – 11.3	8 – 12.5
4	<b>Mean</b>	9.99	10.14

5	<b>SD</b>	0.58	0.98
6	<b>Identification point</b>	<8	>11.3
7	<b>Calculated Range</b>	8.84 – 11.15	8.17– 12.11
8	<b>Demarking point</b>	<8.17	>11.15
9	<b>% of identified bone</b>	0	16

**\*\*t value = 1.01 , p= 0.31( Not significant)**

Table no.3 shows the study of ventral straight breadth of sacrum. The mean value for males is  $9.99 \pm 0.58$  cm and for females is  $10.14 \pm 0.98$  cm. The difference between genders is statistically not significant. The range for male sacra is 8.3 - 11.3cm and for female sacra is 8 – 12.5cm. The Identification Point (IP) for male sacra is <8cm and that for female sacra is >11.3cm. The calculated range (mean  $\pm$  2 S.D.) for male sacra is 8.84 –11.15cm and that for female sacra is 8.17 –12.11 cm. The Demarking Point (DP) for male sacra is <8.17cm and for female sacra is >11.15cm. From this demarking point 0% male and 16% female bones can be identified respectively. The same is represented graphically in the following graph 3.

**Table 4: Distribution of Transverse Diameter of Base (cm) of Sacrum in different gender**

<b>Sr. No.</b>	<b>Detailed measurements</b>	<b>Male</b>	<b>Female</b>
<b>1</b>	<b>Distribution of Transverse diameter of base (cm)</b>	<b>No. of Sacra</b>	<b>No. of Sacra</b>
	8 - 9	0	2
	9 - 10	14	11
	10 – 11	38	20
	11 – 12	18	15
	12 – 13	0	2
<b>2</b>	<b>Total No. of Bones</b>	70	50
<b>3</b>	<b>Range</b>	9.2 – 11.7	8.2 – 13.2
<b>4</b>	<b>Mean</b>	10.65	10.68

5	SD	0.56	0.93
6	Identification Point	<8.2	>11.7
7	Calculated Range	9.52– 11.77	8.83 -12.53
8	Demarking Point	<8.83	> 11.77
9	% of Identified Bone	0	12

\*\* t =0.40, p=0.68, (Not significant)

Table no.4 shows the study of transverse diameter of base of sacrum. The mean value for males is  $10.65 \pm 0.56$  cm and for females is  $10.68 \pm 0.93$  cm. The difference between genders is statistically not significant. The range for male sacra is between 9.2 - 11.7cm and for female sacra between 8.2 – 13.2cm. The Identification Point (IP) for male sacra is <8.2cm and that for female sacra is >11.7cm. The calculated range (mean  $\pm$  2 S.D.) for male sacra is between 9.52 – 11.77cm and that for female sacra is between 8.83 –12.53 cm. The Demarking Point (DP) for male sacra is <8.83cm and for female sacra is >11.77 cm. From this demarking point 0% male and 12% female bones can be identified respectively.

**Table 5: Distribution of Transverse Diameter of Body of S1 in different gender**

Sr. No.	Detailed measurements	Male	Female
1	<b>Distribution of Transverse diameter of body of S1(cm)</b>	<b>No. of Sacra</b>	<b>No. of Sacra</b>
	3 – 4	16	32
	4 – 5	47	17
	5 – 6	07	01
2	<b>Total No. of Bones</b>	70	50
3	<b>Range</b>	3.6 – 5.4	3 – 5.5
4	<b>Mean</b>	4.43	3.85
5	<b>SD</b>	0.44	0.55
6	<b>Identification Point</b>	> 5.5	< 3.6

<b>7</b>	<b>Calculated Range</b>	3.56 – 5.31	2.75 – 4.95
<b>8</b>	<b>Demarking Point</b>	> 4.95	< 3.56
<b>9</b>	<b>% of Identified Bone</b>	18.57	30

**\*\*t = 6.41, p<0.0001 (Highly significant)**

Table no.5 shows the study of transverse diameter body of S1 vertebra. The mean value for males is  $4.43 \pm 0.44$  cm and for females is  $3.85 \pm 0.55$  cm. The difference between genders is statistically highly significant. The range for male sacra is between 3.6 – 5.4cm and for female sacra between 3 – 5.5cm. The Identification Point (IP) for male sacra is >5.5cm and that for female sacra is <3.6cm. The calculated range (mean  $\pm$  2 S.D.) for male sacra is between 3.56 – 5.31cm and that for female sacra is between 2.75 – 4.95cm. The Demarking Point (DP) for male sacra is >4.95cm and for female sacra is <3.56cm. From this demarking point 18.57% male and 30% female bones can be identified respectively.

The mean value for males is  $3.07 \pm 0.2$  cm and for females is  $2.75 \pm 0.21$  cm. The difference between genders is statistically highly significant. The range for male sacra is between 2.5 – 3.5cm and for female sacra between 2.3 – 3.2cm. The Identification Point (IP) for male sacra is >3.2cm and that for female sacra is <2.6cm. The calculated range (mean  $\pm$  2 S.D.) for male sacra is between 2.67 – 3.46cm and that for female sacra is between 2.33 – 3.16cm. The Demarking Point (DP) for male sacra is >3.16cm and for female sacra is <2.67cm. From this demarking point 28.57% male and 30% female bones can be identified respectively.

The mean value for males is  $3.31 \pm 0.63$  cm and for females is  $3.58 \pm 0.5$  cm. The difference between genders is statistically highly significant. The range for male sacra is between 2.6 – 4.2cm and for female sacra between 2.2 – 4.4cm. The Identification Point (IP) for male sacra is <2.2cm and that for female sacra is >4.2cm. The calculated range (mean  $\pm$  2 S.D.) for male sacra is between 2.68 – 3.95cm and that for female sacra is between 2.59 – 4.57 cm. The Demarking Point (DP) for male sacra is <2.59cm and for female sacra is >3.95cm. From this demarking point 0% male and 24% female bones can be identified respectively.

The mean value for males is  $3.27 \pm 0.31$  cm and for females is  $3.57 \pm 0.48$  cm. The difference between genders is statistically highly significant. The range for male sacra is between 2.6 – 4 cm and for female sacra between 2.2 – 4.4 cm. The Identification Point (IP) for male sacra is <2.2cm and that for female sacra is >4cm. The calculated range (mean  $\pm$  2 S.D.) for male sacra is between 2.66 – 3.88cm and that for female sacra is between 2.61 – 4.53cm. The Demarking Point (DP) for male sacra is <2.61cm and for female sacra is >3.88cm. From this demarking point 2.85% male and 32% female bones can be identified respectively.

The mean value for males is  $3.29 \pm 0.29$  cm and for females is  $3.58 \pm 0.48$  cm. The difference between genders is statistically highly significant. The range for male sacra is between 2.6 - 4cm and for female sacra between 2.2 –4.4cm. The Identification Point (IP) for male sacra is  $<2.2$ cm and that for female sacra is  $>4$ cm. The calculated range (mean  $\pm 2$  S.D.) for male sacra is between 2.71 –3.88cm and that for female sacra is between 2.61 – 4.54cm. The Demarking Point (DP) for male sacra is  $<2.61$ cm and for female sacra is  $>3.88$ cm. From this demarking point 2.85% male and 40% female bones can be identified respectively.

The mean value for males is  $58.95 \pm 9.73$  gms and for females is  $49.05 \pm 11.44$  gms. The difference between genders is statistically highly significant. The range for male sacra is between 37.8 – 91.6 gms and for female sacra between 31 – 79.8 gms. The Identification Point (IP) for male sacra is  $>79.8$ gms and that for female sacra is  $<37.8$ gms. The calculated range (mean  $\pm 2$  S.D.) for male sacra is between 39.49 –78.41 cm and that for female sacra is between 26.17 – 71.92 cm. The Demarking Point (DP) for male sacra is  $>71.92$ gms and for female sacra is  $<39.49$ gms. From this demarking point 8.57% male and 16% female bones can be identified respectively.

## DISCUSSION

In the present study, 120 sacra (70 male + 50 female) were studied from Maharashtra region. The sex determination of these bones was done using the different measurements and indices. The demarking point for each parameter is calculated and percentage of bones identified by demarking point for each parameter are calculated. An attempt is made in the present study to simultaneously compare the results of present study with previous studies with the help of comparison tables. However, for some parameters it is not possible to make comparison tables due to unavailability of that in published articles.

### 1) Mid Ventral Straight Length :-

The mean value for male sacra is significantly higher than in female sacra.

The findings of present study agrees with the findings of- Math SC et al <sup>[1]</sup> and Sachdeva K et al <sup>[4]</sup>. However, the mean length of male sacra in present study is lower than those studied by Raju et al <sup>[8]</sup> and by Mishra et al <sup>[9]</sup> but it is greater than those studied by Mazumdar S et al <sup>[3]</sup> and that of Australian aboriginal sacra studied by Davivongs <sup>[10]</sup>. Whereas, the mean length of female sacra in present study is found to be greater than those studied by Mishra et al <sup>[9]</sup>, Mazumdar S et al <sup>[3]</sup> and Raju et al <sup>[8]</sup>.

Thus there exists regional and racial difference in the length of sacrum. This difference could be due to environmental and genetic factors.

### 2) Mid Ventral Curved Length of Sacrum :-

The sacrum measuring its Mid Ventral Curved Length  $>11.64$ cm is definitely a male and the one measuring  $<8.47$ cm is definitely a female.

12.85% male bones and 14% female bones do not overlap.

the findings of present study agrees with the findings of Sachdeva K et al [4]. The accuracy of this parameter is more in identifying female bones (14%) than male bones (12.85%) from the present study.

### **3) Ventral Straight Breadth Of Sacrum :-**

The mean value of Ventral Straight Breadth of male and female sacra in present study matches with the findings of Davivongs (1963) [10] in Australian aboriginal sacra. While, amongst Indian studies, the mean value for male and female sacra in present study is found to be lesser than those studied by Sachdeva K et al [4], Math SC et al [1], Raju et al [8] and Mishra et al [9]. However, in all the cases including our study the mean value for male sacra is lesser than that for female and this difference is statistically insignificant.

### **4) Transverse Diameter of Base of Sacrum in CMS :**

The Demarking point for male sacra is <8.82cm and that for female sacra is >11.77cm.

0% male and 12% female bones do not overlap.

the findings of present study agrees with the findings of Raju et al [8] and Mazumdar et al [3] as in these studies the difference between the male and female means is statistically insignificant as found in our study. However, the mean transverse diameter of base of male and female sacra in present study is greater than those studied by Raju et al [8] and Mazumdar et al [3].

### **5) Transverse Diameter of Body of First Sacral Vertebra :**

18.57% male and 30% female bones do not overlap.

the mean value of transverse diameter of body of 1<sup>st</sup> sacral vertebra for male sacra is less than the mean value observed by Mishra et al [19] and Math SC et al [1]. But the mean value for female sacra in present is found to be similar with the mean value for female sacra observed by Math SC et al [1].

The accuracy of this parameter is more in identifying the female bones (30%) from male bones (18.57%) in present.

### **6) Antero-Posterior Diameter Of First Sacral Vertebra :**

The sacrum measuring its Antero-Posterior Diameter of Body of First Sacral Vertebra >3.16cm is definitely a male and the one measuring <2.67cm is definitely a female.

28.57% male and 30% female bones do not overlap.

the mean value for antero- posterior diameter of 1<sup>st</sup> sacral vertebra in male and female in the present study are similar to the mean values for male and female observed by Raju et al(1980) [8].

This parameter is near about equally accurate in identifying male and female bones in present study.

### **7) Length Of Rt. Ala Of Sacrum :-**

The demarking point for male sacrum is <2.59cm and for female sacrum is >3.95cm.

0% male and 24% female bones do not overlap. Thus the accuracy of this parameter is more for female sacra.

Difference between male & female mean is statistically significant.

Till date very few individual sexual dimorphic study on length of Rt. And Lt. wing of sacrum has been done. In present study we found statistically highly significant difference between male and female on Right side.

Thus this parameter can be used for sexual dimorphism individually.

8) **Length Of Lt. Ala Of Sacrum** :The demarking point for male is <2.61cm and for female is >3.88cm and from these respective demarking points 2.85% and 32% bones can be identified as male and female bones respectively. Thus the accuracy of this parameter is more for identifying the female sacra.

Difference between male & female mean is statistically significant.

Similar to the above parameter, till date very few individual sexual dimorphic study on length of Rt. And Lt. Ala of sacrum has been done. In present study we found statistically highly significant difference between mean length of left ala of sacrum in male and female.

9) **Mean Length Of Ala of Sacrum :-**

. the findings of present study goes more in line with the findings of Mishra et al (2005) <sup>[11]</sup> from Agra region, where the mean value for female was higher than that for male and the difference in mean was statistically significant. The accuracy of this parameter is greater in identifying the female sacra (40%) from the present study.

10) **Weight of sacrum :-**

Till date very few studies are conducted on weight of sacrum. In our study we found the statistically significant difference between male & female mean.

## CONCLUSION

The following parameters-Antero-Posterior Diameter of Body of 1<sup>st</sup> Sacral Vertebra, Transverse Diameter of Body of 1<sup>st</sup> Sacral Vertebra, Mid Ventral Curved Length, Weight of Sacrum, Mid Ventral Straight Length, Mean Length of Ala, Length of Left Ala and Right Ala of Sacrum are found to be more accurate in sexing the sacra depending upon the percentage of identified bones by demarking point. Thus they will help in sexing the unknown samples of sacra

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