

Determination of Sex from Sacrum: Its Forensic Utility

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ABSTRACT

Background: Aim of the study is to determine sex of sacrum using different parameters like curved length, vertical length, anteroposterior diameter and transverse diameter of first sacral vertebra, width of sacrum, length of ala and extent of sacral hiatus. **Materials & Methods:** The intact sacra of 110 adult human of known sex obtained from government medical college Aurangabad. The various parameters like length, width, curved length, anteroposterior and transverse diameter of first sacral vertebra were measured by using thread, sliding caliper and ruler. Several indices like sacral index, curvature index corporobasal index and alar index were calculated. **Results:** Demarking points were evolved and none of the parameters appeared to be promising in identifying sex, except transverse diameter of first sacral vertebra and length of sacrum which is useful in study of medico-legal cases. Various indices were calculated using standard formula for each, the mean and standard deviation for each index was calculated along with demarcating points which determine sex with about 100 percent accuracy.

Key Words: Sex Determination, Sacrum

INTRODUCTION

The sacrum is an important bone so far as sex determination is concerned and a very little metrical data is available on Indian population. Anatomists, anthropologists and forensic experts have always been challenged to determine the sex of skeletal remains to establish the identity of a person. Once sex is determined, the half of the suspected population is excluded from further investigation. Over the years different researchers have carried out various types of measurements on human sacra of different races and regions. One of the well known methods for sex determination using sacra is by sacral index method. As the available literature clearly showed

that the sacrum has not been widely studied in India, therefore few researchers have undertaken the study of sacrum. According to, the metrical study of sacrum has been carried out earlier by Wilder (1920)¹, Faweeet (1938)², Davivongs (1963)³ and Jit & Singh (1966)⁴ advocated the demarcating point (DP) which identifies sex with 100 percent accuracy. Singh and Gangrade (1968)⁵ have said that within the same population the mean value can be significantly different in bones from different zones. Singh and Singh (1972)⁶ have shown that demarcating points (DP) should be calculated separately for different regions of the population, the available literature shows that the Indian sacra has not been studied widely except by Singh and Raju (1977)⁷ and Jana et al (1988)⁸. Hence the present study was undertaken with a view to study the sex-differences in the sacra among the Maharashtrian population. The purpose of this study was to develop discriminant functions which can be used for sex determination on measurements of the pelvis of modern Greeks.

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(Received on 14.01.2011, accepted on 28.01.2011)

MATERIAL & METHODS

The present study was carried out on intact sacra of 110 adults which include 70 male and 40 female. The following measurements were recorded using thread, sliding caliper and ruler.

- 1] CL Curved Length
- 2] VL Vertical Length
- 3] AP- S1 Anteroposterior diameter of S-1 vertebra
- 4] T- S1 Transverse diameter of S-1 vertebra
- 5] W- S1 Total width of sacrum
- 6] LA Length of ala
- 7] E Extent of sacral hiatus

The transverse and anteroposterior diameter of first sacral vertebra and length of ala was measured using sliding caliper. The transverse diameter [T-S1] of first sacral vertebra was measured by taking one point on each side of the lateral most point on superior surface of the vertebra. The anteroposterior diameter [AP-S1] was measured by taking one point on anterosuperior border and another on posterosuperior border of the 1st sacral vertebra by means of the sliding caliper. The curved length

[CL] was measured from upper border of body of first sacral vertebra to lower border of body of fifth sacral vertebra using thread and the length was taken using a ruler in centimeters. The vertical length [VL] was measured using vernier caliper between upper surface of body of 1st sacral vertebra and lower end of fifth sacral vertebra in centimeters. Anteroposterior diameter [AP-S1] and transverse diameter [T-S1] across the body of 1st sacral vertebra of first sacral vertebra was measured using vernier caliper in centimeters. The width of sacrum [W] across the entire upper surface including ala and body of 1st sacral vertebra was measured using vernier caliper in centimeters, and length of ala [LA] between lateral aspect of body of 1st sacral vertebra and the right or left border of sacrum on the upper surface of sacrum was measured using vernier caliper in centimeters. The extent of upper end of sacral hiatus [E] was noted to the level of dorsal sacral intervertebral foramina.

From the above parameters values of mean and standard deviation were calculated from each parameter.

The range for each parameter was calculated using statistical analysis along with mean and standard deviation, the P value was determined to find out whether the sexual difference between the two means was significant or not.

$$\begin{aligned}
 1) \text{Sacral index} &= \frac{\text{Width of sacrum}}{\text{Vertical length of sacrum}} \times 100 \\
 2) \text{Alar index} &= \frac{\text{Vertical length}}{\text{Midventral vertical length}} \times 100 \\
 3) \text{Index of body of 1}^{\text{st}} \text{sacral vertebra} &= \frac{\text{Anteroposterior diameter of 1}^{\text{st}} \text{sacral vertebra}}{\text{Transverse diameter of 1}^{\text{st}} \text{sacral vertebra}} \times 100 \\
 4) \text{Corporobasal index} &= \frac{\text{Transverse diameter of 1}^{\text{st}} \text{sacral vertebra}}{\text{Width sacrum}} \times 100 \\
 5) \text{Curvature index} &= \frac{\text{Vertical length}}{\text{Curved length}} \times 100
 \end{aligned}$$

RESULTS

The mean, calculated range and demarking points of various parameters and percentage of

bones in which sex could be determined by them is given in table 1. None of the parameters showed any promising result except transverse diameter of first sacral vertebra and vertical length of sacrum.

Table 1: Demarking points for various parameters of sacrum for determination of sex in Maharashtrian population

Diameter	M/F	Mean ± S.D	Calculated range	Demarcating Point (D.P.)	No. Beyond D.P.	Percentage Beyond D.P.
Vertical Length	M	9.93 ±1.93	3.24 - 20.1	>9.8	(48)	(68.57)
	F	9.29± 1.30	5.12 - 9.87	<3.2	(0)	(0)
Transverse Diameter 1st Sacral Vertebra	M	3.92 ± 4.07	8.3 -16.1	>4.2	(13)	(18.57)
	F	3.31±3.66	7.67 - 4.28	<2.3	(0)	(0)
Width of Sacrum	M	11.52±1.55	1.39 - 22.7	>11	(12)	(17.14)
	F	11.57 ±1.59	0.63 - 11.0	<1.3	(0)	(0)
Alar Index	M	68.76±3.81	12.31-114.8	>73.22	(8)	(11.42)
	F	121.86±3.12	28.21-73.22	<12.31	(0)	(0)

The findings of the study showed that the female sacra are shorter and wider while male sacra are longer and narrower. We have

determined sex of 48 male sacra using vertical length, 13 male sacra from transverse diameter of first sacral vertebra, 12 male sacra from width of sacrum, and 8 male sacra from alar index.

Fig. 1: Female Sacrum short and wider



Fig. 2: Male sacrum long and narrow

DISCUSSION

Most of the investigators have concluded that sacrum depicts definite sex and ethnic character, it is seen from table -2 that sacral index is higher in females than in males irrespective of the type of population. In findings of our study the sacral index for Maharashtrian female is 119.6 which are greater than that for Maharashtrian males 101.3, this indicates that female sacra are shorter and wider while male sacra are longer and narrower.

COMPARISON OF SACRAL INDICES

The sacral index in case of males in Agra region is 98.21 similar observation was reported by Jana et al (1988) ⁹ in their study of sacra of Budhwan

region. (the mean sacral index of the male being 95.7(cited by Mishra S.R et al in 2003)¹⁰

The present study in the Indian Maharashtrian population the mean sacral index is 101.3 which belong to subplatyhieric group.

On the basis of sacral index the sacrum has classified into three groups

1. Dolicohieric - S1 below 100,
2. Subplatyhieric - S1 between 100-106
3. Platyhieric - S1 above 100

According to Wilders classification Maharashtrian female sacra belong to platyhieric group while Maharashtrian male sacra belong to subplatyhieric group. A comparison of the mean, range and standard deviation of the sacral width in present study [11.51 in male and 11.72 females] while the findings of other workers [99.92 in males

Fig. 3: Male and Female Sacrum showing Transverse diameter of body and ala of 1st sacral vertebra



and 101.24 in females] indicates that the sacral width is more in females than males¹⁰⁻¹¹.

Similarly a comparison of mean vertical length of sacrum of present study [9.93 males and 9.29 females] with findings of other workers like Raju et al (1981)¹² [10.49 males and 9.27 females] indicates that the mean vertical length is lower in females than males. From above findings we can conclude that maharashtrian female sacra have more width and less vertical length thus we can say that female sacra are shorter and wider while male sacra are longer and narrower.

The limiting points of an actual range of every measurable parameter in males and females are taken as identification points [I.P.s] to ascertain sex to an unknown bone but the fallacy of such I.P. has been discussed by Singh & Raju [1977]⁷ to be certain calculated range is found from standard deviation and mean of any parameter, limiting points of such calculated range have been

called as demarking points (D.P.). by Jit and Singh (1966)⁴ which identify sex with 100 percent accuracy from any given region.

From the study of sacrum carried out by Raju et al¹² in Varanasi region only length of sacra, transverse diameter of s1 vertebra, width of sacrum and alar index were useful in identification of sex of sacrum while other parameters were not useful.

It is observed from Table-1 that the sex of 48 male sacra were determined using a single parameter of vertical length whose demarking point is beyond 9.8 cm with 100 percent accuracy, similarly 13 male sacra (18.57) were determined by using transverse diameter of S1 vertebra whose demarcating point is beyond 4.28 cm, 12 male sacra (17.14 %) determined from width whose demarcating point is 11cm and 8 male sacra determined whose demarcating point is beyond 73.22 was possible.

CONCLUSION

- 1) Sacral index is higher in females (119.6) than males (101.3) thus female sacra belong to platyhieric group while male sacra belong to subplatyhieric group.
- 2) Sacral width is more in females (11.7) than in males (11.5).
- 3) Vertical length is less in females (9.29 cm) than males (9.93)
- 4) 48 male sacra sex determined from single parameter of vertical length whose DP is beyond 9.8 cm with 100 percent accuracy.
- 5) 13 male sacra were determined from transverse diameter of 1st sacral vertebra and 8 male sacra demarcating point is beyond 73.22 from alar index 12 male sacra whose demarcating point is beyond 11cm from width of sacrum could be identified with 100 percent accuracy.

ACKNOWLEDGEMENT

We would like to acknowledge and thank Dr. S. Kadu, Associate Professor, Forensic Medicine, P.D.V.V.P.F. Medical College, Ahmednagar and Dr Bhoopendra Singh, Toxicologist, Dept of Forensic Medicine & Toxicology, RIMS, Ranchi for his valuable suggestion in writing the manuscript.

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