

Study of sacral index and sacral hiatus – In adult dry sacra

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Abstract

Anatomists and anthropologists since long acknowledged the importance of sacrum in the determination of sex of deceased individual. Medicolegally sacrum has great importance. Various parameters and indices were used to determine the sex of sacrum. Among these parameters sacral index significantly varies among male and females. Also Sacral hiatus generally used for administration of epidural caudal block. The knowledge of anatomy of sacral hiatus plays a major role in the success of needle placement. The present study aimed to study the anthropometric measurements of 103 adult sacra (M: F= 70:33), Maharashtra, India. Intact and dry sacrums sourced from the bone banks of Medical colleges in Maharashtra were studied. Sacral index was found to be the best parameter for sex determination of sacrum amongst the parameter studied. However not a single parameter could identify 100% of the bones. In this study of sacral hiatus we have taken features like the shape and extent of sacral hiatus, level of apex and base of sacral hiatus. Therefore, the present study aims to create a database for the SI and sacral hiatus of above mentioned population.

Key Words: Sacrum, Sexual Dimorphism, Sacral Index, Sacral hiatus, caudal epidural anesthesia.

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INTRODUCTION

Sacrum is large triangular bone forming posterosuperior wall of the pelvic cavity wedged between two hip bones. Five sacral vertebrae fuse to form sacral bone at the lower end of vertebral column. Sacrum support erect spine and provide strength and stability to the bony pelvis for transmitting body weight. Sex determination is an integral part and first step of biological profile of human osteology. The well known method for determine the sex of sacrum is Sacral Index as explained by Hardlicka's Practical Anthropometry¹. Sacral Index is calculated by

formula - Sacral Index = Width of sacrum x 100 / Height of Sacrum. The nutritional, geographic and occupational factors also affect the morphological features over the bones². Sacral hiatus is also commonly studied parameter. Pair of 5th sacral nerves, a pair of coccygeal nerves passes thorough Sacral hiatus. It is important for anesthesiologist and orthopedic surgeon as caudal anesthesia is given by this route. Anatomical variations of sacral hiatus may lead to epidural block failure. Caudal epidural anaesthesia is done through sacral hiatus. Many variations are found in anatomy of sacral hiatus which leads to failure of caudal epidural block. Tsui *et al* studied that caudal epidural block has 25% failure rate. So knowledge of the anatomical variation like absence of sacral hiatus and narrowing of sacral canal is required for successful completion anesthetic procedures. Caudal anesthesia was first described by two French physicians, Fernand Cathelin and Jean-Anthanase Sicard¹⁴. Caudal epidural block is used for anaesthesia and analgesia below umbilicus in young ages and in urgent procedures like lower limb surgery perineal procedure, incarcerated hernia and in superficial operations such as skin grafting.

MATERIAL AND METHODS

This study was carried out on 103 sacra of known sex. Various anthropometric measurements were done using vernier caliper. The measurements done are as follows.

Maximum length of sacrum (Ventral straight length): Was measured with the help of vernier caliper from the middle of the antero-superior margin of sacral promontory, in the midsagittal plane to the middle of antero-inferior margin of the last sacral vertebra. (Figure 1)

Maximum breadth of sacrum at base: with the help of vernier caliper, the maximum transverse distance between the lateral midpoint of left and right alae of sacrum. (Figure 2)

Sacral Index: Maximum breadth of sacrum at base x 100 divided by Ventral straight height of Sacrum

Different parameters of sacrum like the shape and extent of sacral hiatus were studied. Level of apex and base of sacral hiatus were noted.



Figure 1: Measuring the maximum length of sacrum Fig. 2 Measuring the maximum width of sacrum.

RESULT

In the present study, total of 103 sacra of known sex were studied. The length and breadth of specimens were taken and the results were analyzed as described below (Table No. 1)

1. The mean length (mm) of sacrum in male was 99.5± 10.16 and in females it was 92.36±10.28.

P-value is < 0.0001 found to be statistically significant.

2. The mean breadth (mm) of sacrum in males was 94.8±10.12 and in females it was 103.84±2.02. P-value is 0.0001 is found to be statistically significant.
3. The mean sacral index was 95.67 in males and 103.84 in females.

Table 1: Showing the values of present study

Sex	Mean Length (mm)	Mean Breadth (mm)	Sacral Index			P Value	Calculated range Mean + 3 S.D.	D.P. for sacral index
			Mean	Range	S.D.			
Male (70)	99.5	94.8	95.67	82.8 -107.6	5.20		84.24-114.72	< 93.88
Female (33)	92.36	95.91	103.84	95.13 -110.82	5.9	< 0.0001	94.37 – 126.42	> 112.21

It was observed that, Inverted U shape was the predominant shape of sacral hiatus constituting 38.5% of cases in the present study. It was followed by Inverted V shape. Different shapes of the sacral hiatus found in the present study are shown in Table no. 2.

Table 2: Shape of sacral hiatus

Features	Different Shapes of Sacral Hiatus							
	Inverted U	Inverted V	Dumb – bell	Bifid	Irregular	Partial Deficient	Complete Deficient	Absent
Percentage	38.5	34	05	03	10	00	04	06



Figure 3: Inverted - U shape Sacral Hiatus Figure 4: Dumb - Bell shape Sacral Hiatus.

Table 3: Level of Apex of Sacral Hiatus

Features	Level of Apex of Sacral Hiatus					Deficient
	First Sacral Segment	Second Sacral Segment	Third Sacral Segment	Fourth Sacral Segment	Fifth Sacral Segment	
Percentage	00	03	42	39	02	14

DISCUSSION

Human sacral bone is one of the important bones used for determination of sex. In present study, sacral index was 95.67 in males and 103.84 in females. Sacral length is more in male as compared to female. The mean sacral index in our study was 95.67 in male, which is correlated

with Sibani mazumdar *et al* (94.9) and Dhapate *et al* 94.58^{3,4}. The mean sacral index for female in present study was 103.84, which is well correlated with findings of Jana *et al* (103.89)⁵. Rest of the studies showed high mean sacral index for female as compared to our study. (Table 4).

Table 4: Comparative studies of sacral index according to sex

Sr. No	Studies	Male				Female				S.S.D.
		No. of cases	Mean	Range	S.D.	No. of cases	Mean	Range	S.D.	
1	Jana <i>et al</i> (1987)	-	91.27	83.3 -112.5	-	-	103.89	89.61-115.7	-	-
2	Singh <i>et al</i>	26	94.32	76.3 -110.94	-	12	104.81	95.77 -113.85	-	-
3	Dhapate S.(1997)	117	94.58	77.27 -118.42	6.96	83	104.27	85.0 -136.36	10.675	0.05
4	Mishra <i>et al</i> (2003)	74	98.21	90 -108	4.89	42	117.84	103 - 131.25	7	< 0.001
5	Patel <i>et al</i> (2005)	32	96.25	90.5 – 106	4.6	32	113.25	104.8 - 131	5.74	< 0.001
6	Shilaja C. Math (2006)	190	94.24	53.57- 152	11.78	64	113.19	91.89- 146.15	10.26	< 0.001
7	Kaur A. <i>et al</i> (2010)	20	93.685	58.9-128.38	11.57	20	125.35	90.94- 159.76	11.47	< 0.0001
8	Sibani mazumdar <i>et al</i> (2012)	127	94.9	80.5- 109.3	4.8	123	109.8	87.9 - 131.7	7.3	< 0.0001
9	Ravichandran <i>et al</i> (2013)	63	96.32	80.7 – 106.4	5.4	60	102.29	93.1 – 108.8	4	< 0.0001
10	Sushma K Kataria (2014)	42	104.11	5.86	-	32	120.01	-	8.75	-
11	Present study	70	95.67	82.8 – 107.6	5.20	33	103.84	95.13– 110.82	5.9	< 0.0001

In the present study, Inverted U shaped sacral hiatus was found more commonly that is 38.5%. This finding is fairly correlated with findings of Nagar *et al* and Seema *et al*. (Table No. 5)^{16,18}. Inverted ‘V’ shape finding was 34% in present study which comparable with finding with Osunwoke *et al* as they found it 33.3%¹⁸. In 10 % of sacra were like irregular shape which is low when compared to previous workers namely Nadeem *et al* in 16% and Seema *et al* 16.10%.^{16,18}. But finding in present study were higher when we camper with Qudusia *et al* as they found it 8.76%.

Table 5: Comparison between different studies regarding shapes of the sacral hiatus

Sr. No.	Studies	Inverted ‘U’ shape (%)	Inverted ‘V’ shape (%)	Irregular (%)
1	Nadeem <i>et al</i> .	56	14	16
2	Nagar <i>et al</i> .	41.5	27	14.1
3	Osunwoke <i>et al</i> .	24.1	33.3	13.0
4	Qudusia <i>et al</i> .	62.37	22.16	8.76
5	Seema <i>et al</i>	42.95	27.51	16.10
6	Present study	38.5	34	10

The sacrum develops from the fusion of five sacral vertebrae. Each half of the vertebral arch fuses posteriorly to form complete sacral canal. Lamina of 5th sacral vertebra fails to fuse posteriorly and thus form sacral

hiatus. Sacrum exhibit many variations especially in sacral hiatus. Shape and extent of the hiatus depends on the number of laminae that fails to fuse in the midline posteriorly.

CONCLUSION

The present study showed a significant difference among the average male and female sacral indices. The present study would be of useful to anatomists in medicolegal case to determine sex of the skeleton, forensic experts and anthropologists. Studies which are conducted confirm that the mean sacral index in females is higher than the male sacral index. There are many variations at sacral hiatus in shape and extent of sacral hiatus. Knowledge of these variations are very important for anesthetist, surgeons and orthopedicians. Due to it success of caudal epidural anaesthesia and analgesia depends on it. The detail anatomical knowledge of variations of sacral hiatus is very helpful for the anaesthetists to increased success rate of caudal anesthesia.

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