

Multicentric Morphometric Study of Dry Human Sacrum Of Indian Population In Gujarat Region

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Abstract : Sacrum is a large triangular bone. It is formed by fusion of five sacral vertebrae and forms the caudal region of the vertebral column. It forms posterosuperior wall of the pelvic cavity wedged between the two hip bones. The present study is undertaken to test the validity of the parameters by which it may be possible to know detail morphometry of sacrum and sacral hiatus. The material for the present study consists of 150 adult sacrum of unknown sex. The measuring was done on intact parts of normal bones. Bones showing wear and tear, fracture or any pathology were not considered. Each linear recording was taken to the nearest millimeter. shape and length of the sacral hiatus, level of apex and anteroposterior depth at apex, level of base and transverse width at base were measured with the help of vernier calipers, recorded, tabulated and analyzed. Significant findings in the present study are high, 83 (55.33%) bones showed narrowed sacral canal at the apex (0-3mm), where as previous studies reported 15.6%. This should be kept in mind while applying caudal epidural anaesthesia in Gujarati population.

Key-words: Morphometric Study , Dry Human Sacrum, Indian Population.

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INTRODUCTION: Sacrum is a large triangular bone. It is formed by fusion of five sacral vertebrae and forms the caudal region of the vertebral column. It forms posterosuperior wall of the pelvic cavity wedged between the two hip bones¹.

Due to its great size, the sacrum is usually the last bone of a buried body to rot. The ancients may thus have believed sacrum to be the focal point around which the body could be reassembled in the afterlife. There is some archeological evidence to support the use of sacrum as a vessel to hold the sacrifice in ancient sacred rites. Egyptians considered this bone sacred to "Osiris" the God of resurrection and of agriculture^{2,3}.

It has long been customary among anatomists, anthropologists and forensic experts to judge the sex of the skeletal material by non-metric observations. Lately, sexual divergence has been based upon actual measurements in different bones⁴. Sacrum is one of the bones that exhibit sex differences. Hence it is used in the identification of skeletal remains. Authors have studied sexual

dimorphism wherein sacra of known sex were selected and the validity of the parameters was verified^{5,6}. But in the present work, sacra of unknown sex have been selected. The various parameters of the bone have been studied and attempt has been made to become useful to anesthesiologist in caudal epidural anesthesia, orthopedic surgeries to do the screw fixation surgeries in different cases by knowing the anatomical variation in 14 parameters taken in this study.

The present study is undertaken to test the validity of the parameters by which it may be possible to know detail morphometry of sacrum and sacral hiatus. As many as 14 parameters have been studied. This is a unique study as it has been done in bones of unknown sex. It is hoped that this data will be useful for anatomists, anthropologists, anesthetist, orthopedics and experts in the field of forensic medicine.

MATERIAL AND METHODS: The material for the present study consists of 150 adult sacrum of

unknown sex. These were collected from Govt. Medical college-Bhavnagar, B. J. Mediacal collegeAhmedabad, and Govt. Medical college-Baroda, Ahmedabad Municipal Medical College and P.D.U. Medical College, Rajkot.

The measuring was done on intact parts of normal bones. Bones showing wear and tear, fracture or any pathology were not considered. Each linear recording was taken to the nearest millimeter.

Parameters included were Maximum length of sacrum, Maximum breadth (width) of sacrum, Midventral curved length, Transverse diameters of the body of first sacral vertebra, Anteroposterior diameters of the body of first sacral vertebra, Maximum Length of auricular surface, Maximum width of auricular surface (AS), Mid diameter of auricular surface, Location of apex of sacral hiatus, Location of base of sacral hiatus, Length of sacral hiatus, Antero posterior diameters of sacral canal at the level of apex, Transverse diameters at the level of cornu, Shape of Sacral hiatus. Parameters were measured by using standard method^{4,7}. Microsoft Word and Excel have been used to generate graphs & tables etc

RESULTS: Observations were made in 150 dry, complete, undamaged human sacra, of unknown sex collected from Department of Anatomy, Bhavnagar Medical College , Bhavnagar and other Medical Colleges of Gujarat.

SACRAL HIGHT (straight) is maximum 11 cm in 13 sacrum and it was between 9.1 to 11 in 80 sacrum & 7 to 9 cm in 57 sacrum. SACRAL HIGHT (curved) is maximum 11 cm in 34 sacrum and it was between 9.1 to 11 in 99 sacrum & 7 to 9 8 in 17 sacrum. SACARAL BREATH is maximum 11 cm in 9 sacrum and it was between 9.1 to 11 in 84 sacrum & 7 to 9 cm in 57 sacrum. Diameter including S1-T , S1-AP, Auricular length, auricular width, auricular mid diameter etc are tabulated in table I to VI

Table I

Transverse Length of body of First Sacral Vertebra (S1- T)			
Sr. no.	Length (cm)	No.	Percentage
1	1 to 3	5	3.333
2	3.1 to 5	138	92
3	>5	7	4.667
	Total	150	100

Table II

Antero posterior Length of body of First Sacral Vertebra (S1- AP)			
Sr. No.	Length (cm)	No.	Percentage
1	1 to 3	140	93.33
2	3.1 to 5	10	6.667
3	>5	0	0
	Total	150	100

Table III

Maximum Length of auricular surface			
Sr. no.	Length (cm)	No.	Percentage
1	1 to 3	4	2.667
2	3.1 to 5	87	58
3	>5	59	39.33
	Total	150	100

Table IV

Maximum width of auricular surface			
Sr. no.	Width (cm)	No.	Percentage
1	1 to 3	78	52
2	3.1 to 5	70	46.67
3	>5	2	1.333
	Total	150	100

Table V

Auricular mid length			
Sr. no.	Length (cm)	No.	Percentage
1	1 to 3	146	97.33
2	3.1 to 5	4	2.667
3	>5	0	0
	Total	150	100

Table VI

Transverse Length at the level of cornu			
Sr. no.	Length (cm)	No.	Percentage
1	0-1	44	29.33
2	1.1 -2	100	66.67
3	>2	6	4
	Total	150	100

There were many variations in the shape of sacral hiatus. In 74 (49.33%) sacra the shape was Inverted-U and in 30 (20%) sacra Inverted-V. Both the above types were considered as normal and the sacral hiatus was present against 5th and 4th sacral segments. In 41 (21.1%) specimens, the sacral hiatus was elongated up to the level of 2nd sacral segment in 1 and 3rd sacral segment in 40. A "Dumbbell" shaped sacral hiatus was observed in 6 (4%) cases with a nodular bony growth projecting medially from both margins. The dorsal wall of sacral canal was entirely incomplete in 4 (2%) cases. Absence of sacral hiatus, a rare phenomenon, was observed in 2 (1%) specimens only.

The level of the apex was quite variable and extended between middle of 2nd and middle of 5th sacral segments. In 89 (59.33%) cases the apex was present at the level of 4th sacral segment. In 41 specimens where sacral hiatus was much elongated, the apex was found to be present against 2nd sacral segment in 1 and against 3rd sacral segment in 40, while in 19 (12.67%) cases apex extended only up to the middle of 5th sacral segment.

Base of sacral hiatus was present between middle of 4th sacral segment to middle of 1st piece of coccyx. In 2 (1%) sacra the sacral hiatus was completely obliterated and the lower end of the sacral canal was closed due to bony over growth. In 119 (79.33%) sacra the base of the sacral hiatus was present against the body of 5th and in 16 (10.67%) it was against 4th sacral segment. The measurements of transverse width of base of the sacral hiatus ranged between 1mm to 19mm

The length of the sacral hiatus ranged between 4mm to 57 mm. The arithmetic mean length of the sacral

hiatus was 19.63mm. Complete absence of dorsal wall of sacral canal was observed in 4, and obliteration of sacral hiatus in 2 specimens. These 6 specimens were not considered for the measurements of length.

The anteroposterior Diameter of sacral canal at the level of apex is 0-3mm in 55.33% of sacrum and in only two cases it was above 9 mm and in other it was as shown in table VIII

Table VII

Anteroposterior length of sacral canal at the level of apex (mm)			
Sr. no.	Length	No.	Percentage
1	0-3	83	55.33
2	4-6	58	38.67
3	7-9	6	4
4	Above 9	3	2
	Total	150	100

DISCUSSION: The detailed morphometric study of sacral hiatus is of great relevance, since this route is frequently utilized for caudal epidural anesthesia in perineal surgery and caudal analgesia for a painless delivery.

Edward and Hingson⁸ in 1941, for the first time took the advantage of this natural gap at the lower end of sacral canal for continuous caudal analgesia during labour. Susan Strandring⁹ et al mentions the lower end of sacral canal is an arch shaped sacral hiatus. Sacral hiatus¹⁰ has a somewhat triangular outline when seen from the dorsal aspect. The level of the apex of sacral hiatus lies at the lower third of the body of 4th sacral vertebra and sacral hiatus is the place where caudal epidural anesthesia is given for the operations on sacral dermatomes¹¹.

In the present study the shapes of sacral hiatus were variable; most commonly inverted-U in 79 (52.66%) sacra and inverted-V in 30 (20%) sacra. Both the above types were considered as normal. In 6 (4%) its outline was like a Dumb-bell which was very low when compared to previous workers

namely Nagar SK¹². in 36 (13.3%) sacra and Vinod kumar et al¹³ in 15 (7.43%) sacra. Bifid sacral hiatus was seen in 4 (2.66%) sacra which was similar to that reported by Nagar SK¹². in 4 (1.5%) sacra. There was complete agenesis of sacral hiatus reported by previous workers namely Trotter et al 1.8%, Vinod kumar et al¹³ in 3 (1.49%) sacra and Nagar SK. in 4 (1.5%) sacra. Nagar SK¹² also noted various shapes of sacral hiatus most common being inverted-U in 112 (41.5%) sacra and inverted-V in 73 (27%) sacra. Vinod kumar et al¹³ also noted various shapes of sacral hiatus, most common being inverted-V in 94 (46.53%) and inverted-U in 60 (29.70%). The shape of the sacral hiatus was irregular in 31 (15.5%) sacra in the present study which was again similar when compared to Nagar SK¹² in 38 (14.1%) sacra.

Susan Strandring⁹ et al states that the apex of sacral hiatus is present at the level of 4th sacral vertebra. In the present study the apex of sacral hiatus was seen most commonly at the level of 4th sacral vertebra in 89 (59.33%) sacra, which was almost similar to Vinod kumar et al¹³ in 154 (76.23%) sacra, but was lower in study conducted by Sekiguchi M et al¹⁴ in 60 (65%) sacra and much lower in study observed by Nagar SK¹² in 147 (55.9%) sacra. Earlier studies by Trotter et al¹⁰ have reported the mean level of apex of sacral hiatus to be at lower third of 4th sacral vertebra. All studies including the present study noted that location of apex can vary from upper part of second sacral vertebra to lower part of fifth sacral vertebra.

Base of the sacral hiatus was seen at the level of fifth sacral vertebra in 119 (79.333%) sacra in the present study, which was higher when compared to study conducted by Vinod kumar et al¹³ seen in 168 (83.17%) sacra and much lower when compared to Nagar SK¹² noted in 191 (72.6%) sacra at the level of fifth sacral vertebra out of 270 bones studied.

Length of sacral hiatus varied from 4mm to 57 mm and the arithmetic mean was 22.61 mm and median was 22 mm. This is similar to that reported by earlier workers namely Vinod kumar et al¹³ observed arithmetic mean length of sacral hiatus as 20 mm in males and 18.9mm in females in north

Indians and the reference range was between 3mm to 37mm. Trotter et al¹⁰ have reported sacral hiatus length as 24.8mm and 19.8mm in American males and females respectively. Similar results were noted by Trotter et al¹⁰ in which the length of sacral hiatus varied from 0 to 60mm with arithmetic mean of 22.5mm and Lanier et al noted arithmetic mean length of sacral hiatus being 25.3mm.

Anteroposterior depth of sacral canal at apex of sacral hiatus is important as it should be sufficiently large to admit a needle. Various diameters lead to subcutaneous deposition of anaesthetic drug. In the present study the anteroposterior depth ranged from 1 mm to 9 mm with arithmetic mean of 3.39 mm and median of 3.0. Arithmetic mean of anteroposterior depth reported by various workers are similar Trotter et al¹⁰ 5.3mm (range of 0-11mm), Vinod kumar et al¹³ 4.8mm (range of 0-12mm). Nagar SK¹² 4.8mm (range of 2 - 14mm) and Seikuguchi M et al 6.0mm.

In the present study, sacra having anteroposterior depth of sacral canal at apex of sacral hiatus less than 3mm was observed in 83 (55.33%) bones which is much more higher than the earlier studies namely Trotter et al¹⁰ (1947) who reported only 5% of cases with 0 - 2mm depth and Nagar SK¹² noted in 4 (15.6%) sacra with 0 - 3mm depth.

In Present study anteroposterior depth of sacral canal at apex of sacral hiatus between 4mm - 6mm was seen in 58 (38.67%) bones which was similar to Nagar SK¹² observed in 169 (64.2%) sacrum bones. Arithmetic mean was 3.39 mm in the present study, which was similar to Vinod kumar et al¹³ as 4.8mm.

CONCLUSION: 150 dry human sacra were collected from different colleges of Gujarat and morphometrical studies were done under the following parameters - shape and length of the sacral hiatus, level of apex and anteroposterior depth at apex, level of base and transverse width at base were measured. In the present study are high, 83 (55.33%) bones showed narrowed sacral canal at the apex (0-3mm), where as previous studies

reported 15.6%. This should be kept in mind while applying caudal epidural anesthesia in Gujarati population.

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