



MORPHOMETRY OF SACRAL HITUS IN CENTRAL REGION OF MADHYA PRADESH AND ITS CLINICAL RELEVANCE.

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ABSTRACT

Introduction: Sacrum is a triangular bone at the caudal end of the vertebral column, formed by fusion of five vertebrae. Sacral hiatus is the opening present at the caudal end of sacral canal formed by the failure of fusion of the lamina of the fifth (sometimes fourth) sacral vertebra. A pair of 5th sacral nerves, a pair of coccygeal nerves, filum terminale externa is the structures pass through sacral hiatus. The anatomical knowledge of this region is very important for anesthetist for the success of caudal epidural block. **Aim:** Morphometric study of sacral hiatus, which would be helpful in successful caudal epidural block in population of central region of Madhya Pradesh. **Materials and Methods:** This study was carried out on 75 dry human sacra to know the variations in morphology of the sacral hiatus. **Results:** Various shapes of sacral hiatus were observed which included inverted V 29 (38.66%), inverted U 22(29.33%), and irregular 11 (14.66%) M shaped 04(5.33%) and dumbbell shape 07(9.33%), Spina bifida 01(1.33%) and complete agenesis of dorsal wall of sacrum was in 01(1.33%). The apex of sacral hiatus was commonly found at the level of 4th sacral vertebra in 44 (58.66%) at S3 sacral vertebra in 26(34.66%) and S5 in 03(4%) and at S2 level in only 02 (2.66%) of the sacral vertebra studied. Base of the hiatus was commonly found at the level of S5 in 47 (62.66%) at S4 in 16(21.33%), Cx1 level in 11(14.66%) and at Cx2 level in 01 (1.33) of sacral vertebra. Length of sacral hiatus ranged between 10 mm to 58 mm, breadth at base was 6-27 mm and AP diameter at apex was 0.3–0.9 mm. **Conclusion:** SH shows morphometric variations in various populations. Understanding and knowledge of these variations are essential. This will improve the success of caudal epidural anesthesia. Identification of a single bony landmark may not help in locating SH.

KEYWORDS : Sacral hiatus, CEB, Caudal epidural block

I. INTRODUCTION

The sacrum is a broad triangular bone present in the caudal end of the vertebral column. It helps in the formation of the posterior wall of the pelvic cavity. The sacrum is fixed between two innominate (hip) bones.

Anatomists and anthropologists have since long acknowledged the importance of sacrum in determining the gender of a deceased person¹. In the sacrum, hiatus is formed by incomplete fusion of the dorsal part of the fourth or fifth sacral vertebra. Sacral hiatus (SH) is a significant landmark for performing caudal epidural anesthesia or analgesia in various cases such as low backache, obstetrics well in orthopedic surgeries. Due to these variations, the SH has an appreciable difference in size and shape; it is hard to localize the hiatus during caudal epidural anesthesia.

The surface landmark for SH is present at about 5 cm (2 inches) superior to the tip of fused coccygeal bones underneath the skin of the natal cleft. The SH carries the nerve roots, which include lower sacral nerve fibers, coccygeal nerve roots and filum terminale It is essential to have detailed knowledge of SH for proper access into the caudal (sacral) epidural space.

II. AIMS

It is important to have a detailed knowledge of the anatomical variations in sacral hiatus shape and size for the successful caudal epidural block and to prevent the dural sac puncture. Therefore the present study was conducted to find out the morphology and anatomical variations of sacral hiatus in central region of Madhya Pradesh.

III. MATERIALS AND METHOD

A total number of 75 dried sacrum bones of unknown age and

gender will be included in the study which were collected from Gajra Raja Medical College, Gwalior, M.P.

Only fully ossified, dried and thoroughly cleaned sacra which are complete in all respects, in order to get correct observations, were included in the study. All the parameters were measured by using digital Vernier caliper. The observations were made on following parameters-

- Different shapes of the sacral hiatus and their percentage distribution of each.
- Level of apex of hiatus
- Level of base of hiatus
- Length of hiatus from apex to base
- Antero-posterior diameter of the hiatus at the apex
- Transverse width of hiatus at the base

Representative photographs of different sacrum are taken using a digital mobile camera.

Exclusion criteria

1. Eroded sacrum bones
2. Fractured sacrum
3. Sacras with any kind of other pathology

IV. OBSERVATIONS AND RESULTS

Table 1: Different shapes of sacral hiatus

Sacral shape	No. Of sacra	Percentage
Inverted V	29	38.66
Inverted U	22	29.33
M Shape	04	5.33
Dumbbell Shape	07	9.33
Irregular	11	14.66
Spina Bifida	01	1.33
Dorsal Wall Agenesis	01	1.33



Photo 1: 'V' shape sacral hiatus



Photo 2: 'U' shape sacral hiatus



Photo 3: Complete dorsal wall agnesis

Table 2: Level of Apex and Base of Sacral Hiatus

Sr. No.	Level of apex	No. of vertebra	Percentage	Level of base	No. of vertebra	Percentage
1.	S4	44	58.66	S5	47	62.66
2.	S3	26	34.66	S4	16	21.33
3.	S5	3	4	Cx1	11	14.66
4.	S2	2	2.66	Cx2	1	1.33

Table 3: Length, Breadth & AP diameter of sacral hiatus

Sr. No.	Length (in mm)	No. of sacra	Percentage	Breadth (in mm)	No. of sacra	Percentage	AP diameter (in mm)	No. of sacra	Percentage
1.	1-10	2	2.66	0-5	-	-	0-3	10	1.33
2.	11-20	30	40	6-10	3	4	4-6	43	57.33
3.	21-30	27	36	11-15	26	34.66	7-9	20	26.66
4.	31-40	10	13.33	16-20	41	54.66	10-12	2	2.66
5.	41-50	4	5.33	21-25	4	5.33	-	-	-
6.	51-60	2	2.66	26-30	1	1.33	-	-	-



Photo 4: Measuring length



Photo 5: Measuring breadth



Photo 6: Measuring AP diameter

V. DISCUSSION

Axis of sacrum changes with growth and age of the person and it becomes difficult to locate sacral hiatus in adult. Caudal epidural block has 25% failure rate⁸. The apex of the sacral hiatus is an important bony landmark in the success of CEB but it may be hard to palpate, particularly in obese patients.

Table 5: Morphometry of Sacrum

Sr. No.		Mean ± SD	Min(mm)	Max(mm)
1.	Length of sacral hiatus	22.46 ± 12.393	10	58
2.	Breadth of sacral hiatus	15 ± 2.449	6	27
3.	AP diameter at apex	0.6 ± 0.118	0.3	0.9

The most common shape of sacral hiatus in present study was Inverted V in 29(32.66%) followed by Inverted U in 22(29.33%), Irregular V in 14(14.66%), Dumbbell shape hiatus in 7 (9.33%), M shaped 4(5.33%), Spina Bifida hiatus in 1(1.33%) and complete agnesis of dorsal of the sacrum was in 1 (1.33%) only.

Table: 4 Comparison of Present study with the other studies

Morphological features of sacrum	Present study (2023)	William FM (2017) ²	Arora S (2016) ³	ChabraN (2014) ⁴	Vinod K(1992) ⁵	Nagshree M (2014) ⁶	ShindeA (2015) ⁷	Dona S (2016) ⁸	ShewaleS (2013) ⁹	Bharthi A (2016) ¹⁰
1. Shape										
V-shape	38.66%	44.66%	29.12%	43.75%	46.53%	39.20%	24.00%	14.09%	32.55%	45.00%
U-shape	29.33%	30.66%	22.47%	28.12%	29.7%	23.50%	56.00%	70.09%	40.69%	40.00%
Irregular	14.66%	13.66%	-	-	-	25.4%	10.00%	12.82%	09.80%	-
Dumbbell shape	9.33%	6.66%	-	-	-	9.80%	5.00%	08.50%	09.80%	1.70%
Spina Bifida	1.33%	1.33%	-	-	-	1.90%	2.00%	-	-	1.70%
Agnesis of dorsal wall	1.33%	1.33%	-	-	-	1.90%	2.00%	-	-	1.70%
2. Level of Apex										
S4	58.66%	54.66%	-	-	-	-	-	-	65%	-
S3	34.66%	38.66%	-	-	-	-	-	-	-	-
S5	4%	5.33%	-	-	-	-	-	-	-	-
S2	2.66%	1.33%	-	-	-	-	-	-	-	-
3.Base of hiatus										
S5	62.66%	66.66%	-	63.33%	-	72.4%	77.03%	95.7%	60%	-
S4	21.33%	20.00%	-	20.00%	-	18.9%	11.82%	-	5%	-
Cx1	14.66%	12.00%	-	16.67%	-	8.6%	11.15%	-	3.5%	-
Cx2	1.33%	-	-	-	-	-	-	-	-	-
4.Sacral Hiatus	(In mm)	10-65 mm	-	10-62mm	-	7-76 mms	21-77 mms	8.8-54 mms	23-44 mm male &20-44female	9-60
Length	10-58	10-20mm	-	6-17mm.	5-20mms	9-20 mms	-	6-21mm	0-20	6-29
Breadth	6-27	-	-	-	-	0.2-0.7mms	-	0.2-0.5 mms	1-9mms	-
AP diameter	0.3-0.9	0.3-0.8mm	-	0.4-0.9mm	-	-	-	-	AP less than 0.3 mm in7.5%	0.6-1.3

Apex of sacral hiatus was most commonly seen at 4th sacral vertebra in 44(58.66 %), at 3rd sacral vertebra in 26(34.66%), at 5th sacral vertebra 03(4%) and at 2nd sacral vertebra in 02(2.66%) only. Base of sacral hiatus was commonly located at the level of 5th sacral vertebra in 47 (62.66%), at 4th sacral vertebra in 16(21.33%), at 1st Coccyx in 11(14.66%) and at 2nd Coccyx in 1(1.33%) of sacra studied.

The mean length of sacral hiatus was 22.46±12.393 mm ranging 10-58mms .The mean breadth was 15±2.449 with range from 10 to 27 mms and mean AP diameter of sacral hiatus at apex 0.6±0.118mm respectively with range 0.3 –0.9mms.

Location of apex of sacral hiatus is an important landmark for successful caudal epidural block. It shows considerable variation. The chances of dural puncture are more when the apex of sacral hiatus is located at 2nd or 3rd sacral vertebra.

In the present study apex of the sacral hiatus is at the level of S4 in 44(58.66%), at S3 in 26(34.66), at S5 in 03(4%) and at S2 in 2(2.66) sacras. The base of sacrum was found at 5th sacral vertebra, in 47(62.66%), at 4th sacral vertebra, in 16(21.33%) at Cx1 in 11(14.66%) and at the level of Cx 2 in 1(1.33%) sacras.

The level of Apex and Base and other findings of the present

study are more or less in agreement with those of other authors as named and compared in Table No.4. These findings are close to the study done by Trotter & Lanier¹¹ who reported a mean hiatal length of 24.8 mm in American males and 19.8 mm in females. Similar results were observed by earlier studies of Trotter & Letterman¹² in which the length of the hiatus varied from 0-66 mm with a mean of 22.5 mm and Lanier et al¹¹ where he noted a mean hiatal length of 25.00 ±9 mm. The present and past studies clearly show that the increase in length of hiatus is influenced by the defect and non-union of 2nd or 3rd pair of sacral lamina and also by coccygeal ankylosis.

In the present study the breadth at the base of sacral hiatus varied from 6 to 27 mm with a mean of 22.46 mm. These findings are similar with the studies done by William FM, Jaiswl P, Gupta S. The breadth of sacral hiatus is close to the study done by A. Bharathi, who found mean transverse width of 13 mm with a range of 11-20 mm(90%) and 1-10 mm (5%) and 21-30mm (5%) .Our reading are higher than Chabra N et al⁴ and Arora et al³, who observed mean breadth 12.84 mm range from 6.53-16.99 mm. and mean transverse width of 11.95±2.78 mm. respectively.

The anteroposterior diameter of sacral canal at the apex of hiatus is important to decide on the accurate needle usage for the epidural block. It should be sufficiently large to admit a

needle. The mean AP diameter of sacral canal at apex in present study is 0.6 ± 0.118 mm with a range of 0.3 to 0.9 mm. The findings of the present study is similar to studies done by Sekiguchi et al¹³ and Lanier et al¹¹ where they noted a mean anteroposterior diameter of 6.1 ± 0.2 mm and 6.0 ± 1.9 mm respectively. In our study AP diameter was less than 0.3mm in 14.66% as compared to study by Shewale et al⁹ who had found AP Diameter less than 0.3 mm in 7.5% sacra, while Lanier, Mc Knight & Trotter¹¹ did not find any sacra having AP Diameter less than 0.3mm.

VI. CONCLUSION

The present study was performed to find out various sacral parameters and to emphasize variations in the shapes of SH. Variations in shapes as well as level of base and apex of SH may lead to failure of CEB¹⁵. In this study, we found that the most common shape is V shape. Level of apex is most commonly at the level of S4 and base at the level of S5. Present study concludes in support of other studies regarding variability in the anatomical structure of sacral hiatus. Variations in the shape and level of the hiatus may lead to failure of CEB. So only identification of a single point or landmark in bone may not be helpful in locating the SH. Understanding the variations in SH will improve the success rate of CEB. The incidence of variations may be due to genetic and racial factors. Further clinical trials are required to provide more data to support the results of this study.

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