Morphological and Morphometrical Study of Sacral Hiatus

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Research Article

Abstract: The present study of sacral hiatus was carried on 204 dry human sacra to know the anatomical variations of sacral hiatus. A typical sacrum consisting of 5 segments was observed in 142(69.60%) cases. Various shapes of sacral hiatus were observed and most common were inverted 'U' (83cases;40.69%), inverted 'V' (66cases;32.35%).Complete spina bifida and absence of sacral hiatus was observed in 2 cases(i. e . 0.98%). The apex of sacral hiatus was most commonly located at 4th sacral vertebra in 133(66.5%) cases. Most commonly the base of hiatus was located at 5th sacral vertebra in 164(82%). Mean length of sacral hiatus was 23.44±10.59mm in males and 20.44 ±7.96mm in females. Mean values for transverse width at the base of hiatus observed were 13.68±3.87mm in males and 13.45±2.88mm in females. The mean antero posterior diameter of sacral canal at the apex of sacral hiatus was 5.18mm.Narrowing of sacral canal at the apex of sacral hiatus (diameter less than 3mm) was observed in significant number of cases (15 cases; 7.5%).

Key words: sacrum, sacral hiatus, caudal epidural anaesthesia.

Introduction

On the dorsal surface of sacrum, in the lower part of median sacral crest, an arch shaped opening is present called as sacral hiatus. The sacral hiatus contains 1) a pair of 5th sacral nerves which groove the lateral parts of the 5th sacral vertebra, 2) a pair of coccygeal nerves, 3) filum terminale externa which passes to coccyx and 4) fibro-fatty tissue.[1] On the surface, the hiatus lies about two inches above the tip of coccyx beneath the skin of natal cleft.[2] During perineal surgery, the anesthetic agent is injected in sacral canal through the sacral hiatus so the shape and extent of sacral hiatus is important. The caudal epidural anesthesia and analgesia is obtained by giving the injections of local anesthetics through the sacral hiatus so there is blockage of limited spinal segments. The continuous caudal analgesia is also given through the sacral hiatus which is used in painless delivery. This route was used for first time in 1941.[3]The hiatal measurements were reported for a series of female [4] and male[5] sacra. Keeping in view, the important application of caudal anesthesia and analgesia, the present study has been carried out on dry human sacra in the south and central parts of Maharashtra including emphasis on noting anatomical variations of sacral hiatus.

Material and Methods

The present study was performed on 204 adult human sacra of known sex. All of them were dry fully ossified and free from any deformity. The samples used were from the Department of Anatomy, Dr. V.M.Government Medical College, Solapur and bone bank of Department of Anatomy, Government Medical College and Hospital, Aurangabad. The equipments used for the measurement of various parameters were sliding caliper, divider and steel measuring scale.

Each sacrum was studied for different features of sacral hiatus as follows:

1) Sacral Composition 2) Shape of hiatus 3) Level of apex of hiatus 4) Level of base of hiatus

5) Length of hiatus: Measured from apex to midpoint of base

6) Anteroposterior diameter of the hiatus at the apex

7) Transverse width of hiatus at the base: Measured between inner aspects of inferior limit of sacral cornua.

Observations

Table 1: Sacral composition (n=204)

Sr. No.	Sacral composition	Number of cases	Percentage (%)
1.	4 Segments	5	2.45
2.	5 Segments.	142	69.6
3.	6 Segments Partial or complete sacralisation of 5th lumbar vertebra	20	9.82
4.	Coccygeal ankylosis	37	18.13
	Total	204	100.00

Table 2: Shape of sacral hiatus (n=204)

Sr.No.	Shape	Number of cases	Percentage (%)
1.	Inverted 'U'	83	40.69
2.	Inverted 'V'	66	32.35
3.	Irregular	19	9.31
4.	Elongated	19	9.31
5.	Dumbbell	12	5.89
6.	Complete spina bifida.	02	0.98
7.	Absent hiatus	02	0.98
8.	Aperture in dorsal wall	01	0.49
	Total	204	100.00

Complete spina bifida and absent sacral hiatus were observed in 4 sacra, these cases were excluded in the evaluation of further parameters of sacral hiatus

Table 3: Location of apex of hiatus in relation to the level of sacral vertebra (n=200)

Sr.No.	Location of apex	Number of cases	Percentage (%)
1.	5^{th} sacral vertebra	29	14.5
2.	4^{th} sacral vertebra	133	66
3.	3^{rd} sacral vertebra	30	15
4.	2^{nd} sacral vertebra	08	4

Apex of sacral hiatus extended between lower l/3^{rd} of 2^{nd} sacral vertebra and upper 1/3^{rd} of 5^{th} sacral vertebra.

Table 4: Location of the base of hiatus in relation to sacral /coccygeal vertebrae.(n=200)

Sr.No.	Location of base.	Number of cases	Percentage (%)
1.	4^{th} sacral vertebra	4	2
2.	5^{th} sacral vertebra	164	82
3.	Coccyx	32	16

Base of sacral hiatus was present between the middle of 4^{th} sacral segment to the level of 1^{st} piece of coccyx.

Table 5: Length of sacral hiatus from apex to the midpoint of base (n=200)

Sr no.	Length	Number of cases	Percentage (%)
1.	00 – 10 mm	11	05.50
2.	11 – 20 mm	80	40
3.	21 – 30 mm	74	37
4.	31 – 40 mm	21	10.5
5.	41 – 50 mm	10	05
6.	51 – 60 mm	04	02

Length of hiatus ranged from 5 mm to 53.5 mm. (mean 22.87mm)

Table 6: Anteroposterior diameter of sacral canal at the level of apex (n=200)

Sr.No.	Diameter	Number of cases	Percentage (%)
1.	0 – 3 mm	15	7.50
2.	4 – 6 mm	152	76
3.	7 – 9 mm	32	16
4.	10-12mm	1	0.5

Anteroposterior diameter of sacral canal ranged between 2 to 10 mm (Mean 5.18mm).

Table 7: Transverse width at the base of hiatus (n==200)

Sr.No.	Transverse width	Number of cases	Percentage (%)
1.	00 – 05 mm	2	1
2.	06 – 10 mm	44	22
3.	11 – 15 mm	112	56
4.	16 – 20 mm	42	21

Transverse width at the base of hiatus ranged between 4.5 mm and 20 mm.(mean 13.68mm)

Discussion

Basaloglu et al[6] (2005) showed that the detailed knowledge of morphometric data about sacrum is very important for spinal surgery to prevent neurological injury. Senoglu et al[7] (2005) studied the important landmarks for location of sacral hiatus for caudal epidural block. This route is used in orthopedic therapeutic and diagnostic procedures.[8] Clinically sacral hiatal route is utilized in various procedures. Like in the treatment of sciatica,to give corticosteroids injections.[9] In epidurography, contrast dye is given through an epidural catheter via sacral hiatus.[10] In spinal endoscopy, the caudal canal is to be entered via sacral hiatus.[11] Most commonly sacrum is made up of five sacral vertebrae.[2] In the present study also, sacrum was made up of 5 segments in 142 (69.60%) where as 5(2.45%) cases showed 4 segments .Vinod Kumar et al[12](1992)noted 5 segmented and 4 segmented sacra in 141(69.80%) and 3(1.48%) cases respectively. However, Trotter and Lanier[13] (1945) observed 4 segments in sacrum in 8 (0.7%) cases. Our findings are in agreement with those of Vinod kumar et al.[12] In present study (2012), partial or complete sacralisation of 5th lumbar vertebra and coccygeal ankylosis was observed in 20 (9.8%) cases and 37 (18.13%) cases respectively. Willis[14] (1923) studied 850 thoracolumbar columns and reported that partial and complete sacralisation was present in 4.4% and 1.1% cases respectively. . Trotter and Lanier[13] (1945) observed sacralisation of 5th lumbar vertebra and coccygeal ankylosis in 12.6% and 39.3% respectively. Comparative analysis of shapes of sacral hiatus in present study (2012) was done with those of previous workers.

Table 8: Different shapes of sacral hiatus observed by previous workers

Shape of sacral hiatus	Vinod kumar et al[12](1992) %	Nagar S.K.[15](2004)%	Dr.Zarna Patel et al[16] (2011) %	Present study (2012)%
Inverted U	29.70	41.50	49.33	40.69
Inverted V	46.53	27	20	32.35
Dumb-bell	7.43	13.3	4	5.89
Elongated	13.86	_	21.1	9.31
Irregular	_	14.1	_	9.31
Absent sacral hiatus	0.99	0.7	1	0.98
Complete spina bifida	1.49	1.5	2	0.98

Trotter and Letterman[17] (1944) observed that in 1.8% cases, there was complete spina bifida which corroborates with the present study. Sekiguchi et al[8] (2004) and Senoglu et al[7] (2005) reported that the sacral hiatus was absent in 4% cases and in 6 (6.25%) cases respectively which is more than what was observed in the present study (2012). However, in absent sacral hiatus, the caudal epidural block can not be given. But the caudal analgesia can be given even in complete spina bifida since the dorsal wall of the canal is completed by ligaments.[18] The differences observed in various studies might be due to variations in regional & constitutional factors.

Table 9: Location of apex and base reported by previous authors

Previous authors	Location of apex at S4 (%)	Location of base	
		At S5 (%)	At coccyx (%)
Trotter and Lanier[13] (1945)	65	_	28.9
Vinod Kumar et[12] al(1992)	76.23	83.17	14.35
Vinod Kumar et[19] al(1994)	51.19	_	_
Shinohara[20](1999)	75	_	_
Nagar S.K.[15](2004)	55.9	72.6	_
Sekiguchi[8] (2004)	64	_	_
Dr.Zarna Patel et al[16] (2011)	59.33	79.33	_
Present study (2012)	66.5	82	16

Thus most of the previous studies noted that the apex of sacral hiatus was most commonly located at the level of 4th sacral segment which is in agreement with the present study (2012). Location of apex of the sacral hiatus is important when the apex is located at 2nd or 3rd sacral vertebra. There are more chances for the puncture of dural sac during caudal epidural block as the apex of the hiatus is very close to the lower end of the dural sac. The base of sacral hiatus was located at the lower end of 4th sacral vertebra to the coccyx. The findings of the present study are more or less in agreement with those of Vinod kumar et al[12] (1992), & Nagar[15](2004). However, when the base of sacral hiatus is present at coccygeal level it is little narrower as compared to that of the sacral level.

Table 10: Mean length, Mean AP diameter at the apex and mean transverse width of sacral hiatus reported in previous studies

Previous workers	Mean Length (mm)	Mean A-P diameter of sacral canal at apex (mm)	Transverse width at base (mm)
Trotter and Letterman[13] (1944)	22.5 (0 – 60)	5.3 (0 – 11)	17 (7-26)
Lanier, Mcknight and Trotter[21] (1944)	25.3 +/- 9	6.1 +/- 0.2	19.3 +- 0.3
Trotter and Lanier[13] (1945)	24.8 (American M) 19.8(American F)	–	–
Trotter[18] (1947)	–	5 (White gr.) 6 (Negro gr.)	–
Vinod Kumar et al[12] (1992)	20 (3 – 37) 18.9 (9 – 36)	4.8 (0 – 12)	M-13 (5 -20) F- 12.50(8- 18)
Nagar S.K.[15](2004)	5 - 69	4.88 (2 – 14)	3 – 19
Sekiguchi et al[8] (2004)	–	6.0 +/- 1.9	10.2 +/- 0.35
Park et al[22] (2006)	–	–	17 (9.6 – 24)
Dr.Zarna Patel et al[16] (2011)	22 (4- 57)	3.39 (1 – 9)	
Present study (2012)	23.44 (5 – 53.5) 20.44(9 – 42)	5.18 (2 – 10)	M-13.68 (4.5 – 19) F-13.45 (7.5 – 18)

In present study (2012), the length of hiatus ranged from 5 mm to 53.5 mm(mean 22.87) in males whereas in females the range was 9-42 mm with the mean of 20.44 mm. Thus, in all studies including present one, mean length of hiatus was less in females than in males. The present and past studies clearly show that the increase in length of the hiatus is influenced by the defect of non-union of 2nd and 3rd pair of sacral laminae and also by coccygeal ankylosis. In the present study (2012), 15 (7.50%) sacra showed anteroposterior diameter less than 3 mm. Nagar[15] (2004) and Dr. Zarna Patel et al[16] (2011) reported that the anteroposterior diameter of sacral canal was less than 3 mm in 15.6% and 55.33% cases respectively. These values being higher than that of the present study (2012). Trotter and Letterman[4] (1944) reported 4% sacra with diameter 0- 2mm. Lanier, McKnight and Trotter[21] (1944) noted no case with diameter less than 3 mm. Trotter[18] (1947) reported 5% cases with 0 – 2 mm diameter. The anteroposterior diameter of sacral canal at the apex of hiatus is important as it could be sufficiently large to admit a needle. In the present study, the transverse width at the base of hiatus ranged from 4.5 mm to 19 mm. In the present study (2012),it was 11-15mm in 56%.Values observed by Nagar[15] were same i.e.11 – 15 mm in 54% of cases findings almost similar in present study.

Conclusion

The knowledge of anatomical variations of sacral hiatus is important while administration of caudal epidural anesthesia. In present study, we studied the sacral hiatus in 204 dry human sacra and found elongated hiatus in 9.31% cases, narrowing of sacral hiatus in 7.5% cases, location of apex of sacral hiatus at 2nd and 3rd sacral vertebra in 19% cases in Mahashtritian population. Figures being significant and should be kept in mind while giving caudal epidural anesthesia and analgesia. If sacral hiatus is absent (noted in 2cases; 0.98%) caudal epidural anesthesia can not be given.

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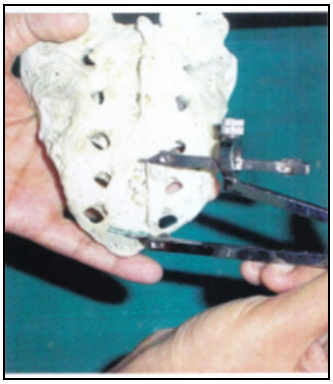


Fig. 1*: Measuring the length of sacral hiatus.*

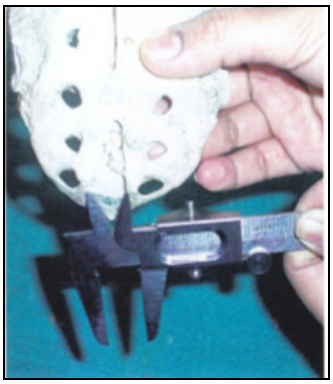
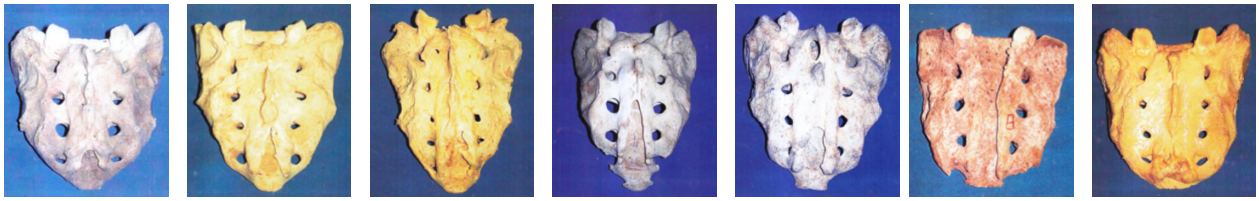


Fig.2*- Measuring the transverse width of sacral hiatus*



(A) (B) (C) (D) (E) (F) (G)

Fig 3*: Different shapes of sacral hiatus observed in the present study (2012). A) Inverted U shaped B) Inverted V shaped C) Irregular D)Elongated E) Dumb-bell F) Complete spinal bifida G)Absent sacral hiatus*