VARIATIONS OF SACRAL HIATUS IN DRY HUMAN SACRA: AN ANATOMICAL STUDY

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ABSTRACT

BACKGROUND

Sacrum is a large triangular bone formed by the fusion of 5 sacral vertebrae. It lies obliquely at the posterior part of pelvic cavity between the two hip bones. It encloses a canal called the sacral canal. The lower opening of the sacral canal is called the sacral hiatus. It transmits the 5th pair of sacral nerves, coccygeal nerves & filum terminale externa.

AIMS & OBJECTIVES

The aim of the present study is to find out the variations of sacral hiatus in this part of Northeast India.

MATERIALS & METHODS

The study was carried out in 104 dry human sacra to know the anatomical variations of sacral hiatus. The measurements were carried out with the help of a Vernier calliper, scale & a divider.

RESULT & OBSERVATIONS

Various shapes of sacral hiatus were observed as follows: Inverted U shaped (53.8%), inverted V shaped (29.8 %), irregular shaped (9.6 %), dumb-bell shaped (5.7 %), bifid (0.9%). The length of the sacral hiatus was found to be between 20-30 mm in 46.1% cases. The apex of the sacral hiatus was at the level of S4 vertebra in 46.1% specimens. The anteroposterior diameter of the sacral canal at the apex of the sacral hiatus ranged from 2-12 mm.

CONCLUSIONS

Variations of sacral hiatus is very common. The knowledge of such variations will definitely help the anaesthesiologists to take proper step while administering caudal epidural anaesthesia to increase the success rate of caudal epidural block.

KEYWORDS

Sacrum, Sacral Hiatus, Epidural Block, Filum Terminale Externa, Coccygeal.

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INTRODUCTION: The sacrum is a wedge shaped bone, with its base uppermost, formed by the fusion of 5 or sometimes 6 vertebrae below the lumbar vertebra.(1) It has a concave pelvic surface & a convex dorsal surface. The dorsal surface has in the middle the fused vertebral arches (Laminae) that cover the sacral canal. The canal is open above & below. At the lower end of the canal, one or two of the arches (Laminae) may be partly deficient giving rise to a gap called the sacral hiatus. The size & shape of the sacral hiatus is variable. It is located inferior to the 4th or 3rd fused sacral spines or lower end of median sacral crest. The sacral hiatus transmits the lower sacral & coccygeal nerve roots, filum terminale externa along with fibro fatty tissue.(2) The hiatus is covered only by skin, a subcutaneous fatty layer & superficial posterior sacrococcygeal ligament which is attached to the margins of the hiatus. The deep posterior sacrococcygeal ligament is attached to the floor of the sacral hiatus.(3) The remnants of the inferior articular process elongates downwards on each side of the sacral hiatus. These two bony processes are called the sacral cornua (horns) & they define important clinical landmarks during caudal epidural block (CEB). Sacral hiatus has been used for administration of epidural anaesthesia in obstetrics & gynaecological cases as well as in orthopaedics. It is identified by palpation of the sacral cornua. Sacral cornua are felt at the upper end of the natal cleft 5 cm above the tip of the coccyx. The sacral hiatus can also be identified by constructing an equilateral triangle based on a line formed by joining the posterior superior iliac spines. The apex of this triangle which lies inferiorly usually overlies the sacral hiatus. CEB involves injection of a drug into epidural space through the sacral hiatus to provide analgesia & anaesthesia in various clinical settings.(4) Even though CEB has a wide range of clinical application, it is sometimes hard to determine the anatomical location of sacral hiatus & the caudal epidural space. The knowledge of variations & application of the landmarks enables a clinician to ascertain the sacral hiatus & thus increase the success rate of CEB.

The present study was undertaken to find out the anatomical variations of sacral hiatus in the state of Assam & to identify additional anatomical landmarks which will help to locate the sacral hiatus in cases where the sacral cornua could not be identified.

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MATERIALS & METHODS: The present study was carried out in the Department of Anatomy at AMCH, Dibrugarh, Assam. A total of 104 dry human sacra of unknown origin were studied for different features of the sacral hiatus such as,

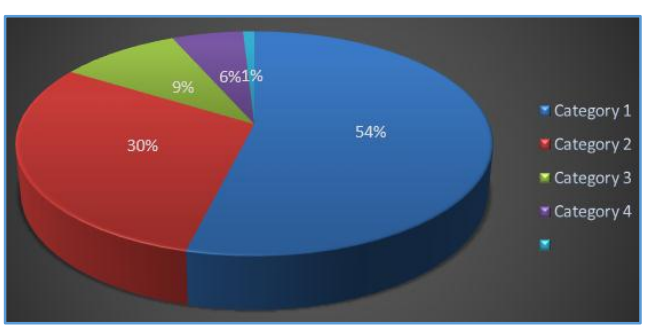
A) Shape of the sacral hiatus.
B) Level of apex of the sacral hiatus.
C) Level of base of the sacral hiatus.
D) Length of the sacral hiatus from apex to midpoint of the base.
E) Anteroposterior diameter of the sacral canal at the apex of the sacral hiatus.
F) Width of the sacral hiatus at the base (intercornual distance).

Inclusion & Exclusion Criteria: Undamaged, adult sacrum of both the sexes were included in this study. We excluded those with complete agenesis of dorsal wall of sacral canal, absent sacral hiatus & those showing wear & tear or fracture.

RESULT & OBSERVATIONS:

Shape	No. of Specimen	Percentage
Inverted U	56	53.8%
Inverted V	31	29.8%
Irregular	10	9.6%
Dumb-bell	6	5.7%
Bifid	1	0.9%

Table 1: Showing shapes of the Sacral Hiatus



Graph 1: Showing the Percentage of Different shapes of Sacral Hiatus

Location of Apex	No. of Specimen	Percentage
At 1st sacral vertebra	0	-
At 2nd sacral vertebra	7	6.7%
At 3rd sacral vertebra	46	44.2%
At 4th sacral vertebra	48	46.1%
At 5th sacral vertebra	3	2.8%

Table 2: Showing level of Location of Apex of Sacral Hiatus

Level of base	No. of specimens	Percentage
At 4th sacral vertebra	8	7.6%
At 5th sacral vertebra	96	92.3%
At coccyx	0	-

Table 3: Showing Level of Location of base of the Sacral Hiatus

Length (mm)	No. of specimen	Percentage
O – 10	4	3.8%
10 – 20	37	35.5%
20 – 30	48	46.1%
30 – 40	8	7.6%
More than 40	7	6.7%

Table 4: Showing Length of the Sacral Hiatus (From apex to the midpoint of the base of Sacral Hiatus)

Distance (mm)	No. of specimens	Percentage
0 -5	7	6.7%
5 – 10	51	49%
10 -15	42	40.3%
Above 15	4	3.8%

Table 5: Showing distance between the two Sacral Cornua

Length (mm)	No. of specimen	Percentage
0 -3	1	0.9%
3 -6	10	9.6%
6 -9	57	54.8%
9 -12	36	34.6%

Table 6: Showing Anteroposterior Diameter of Sacral Canal at the apex of the Sacral Hiatus

In the 104 examined dry human sacra, we observed that the shape of the sacral hiatus vary greatly (Table 1), commonest being the Inverted U type (53.8%) & least common being the Bifid type (0.9%). The level of location of Apex of the sacral hiatus was quite variable (Table 2). It extended between 2nd to 4th sacral vertebra. Level of the apex is of great clinical importance in terms of giving injection during Caudal epidural block (CEB). In majority of the specimens (92.3%), the base of the sacral hiatus was found to be located at 5th sacral vertebra (Table 3). We also observed that the length of the sacral hiatus vary considerably from person to person (Table 4). It was measured from apex to the midpoint of the base of the sacral hiatus. The intercornual diameter ranged between 5-10 mm in 49% of the specimens followed by 10-15 mm in 40.3% specimens (Table 5). In 54.8% of the specimens, the depth of the sacral hiatus at apex was between 6-9 mm (Table 6). However, it ranged between 3-12 mm.

Fig. 1: Dumb-bell shaped

Fig. 2: Inverted U shaped

Fig. 3: Bifid type

Fig. 4: Irregular (a)

Fig. 5: Inverted V (a)

Fig. 6: Inverted V (b)

Fig. 7: Irregular (b)

DISCUSSION:

A) Shape of the sacral hiatus- In our study, we found that the shape of the sacral hiatus was quite variable. We observed 5 shapes of sacral hiatus. They are – Inverted U, Inverted V, Irregular, Dumb-bell & Bifid. The most common types were Inverted U (53.8%) & Inverted V (29.8%). These two shapes provide enough space for needle access during CEB. The other types of shapes provide challenge during CEB.[5]. We compared our findings with the findings of other research workers which are as follows:

Author	Year of study	Shapes with Percentage				
		Inverted U	Inverted V	Irregular	Dumb-bell	Bifid
Kumar et al[6]	1992	27.51%	76.23%	-	7.43%	-
Nagar S K[7]	2004	41,5%	27%	14.1%	13.3%	1.5%
Aggarwal et al[8]	2009	40.35%	-	-	-	-
Muhamed S Mustafa et al[5]	2012	26%	24%	22%	22%	-
Seema et al[9]	2013	42.95%	27.51%	16.11%	13.41%	-
Clarista M.Q & Gautham K[10]	2013	46.2%	24%	9.6%	6.7%	2.9%
S.Bhattacharya et al[11]	2013	65%	23%	12%	-	-
Shilpa N Shewale et al[12]	2013	40.69%	32.35%	9.31%	5.89%	0.49%
Malarvani T et al[13]	2015	35%	32%	14%	3%	2%
Present study	2016	53.8%	29.8%	9.6%	5.7%	0.9%

Table 7: Showing the Various Shapes of Sacral Hiatus as found by Various Workers

In our study, we found more no. of inverted U-shaped sacral hiatuses unlike Kumar et al[6] who reported that inverted V-shape were more common (76.23%) in their study. Our findings correlate with the findings of Nagar SK,[7] Seema et al,[9] S.Bhattacharya et al,[11] Shilpa N Shewale et al[12] etc. In our study, the least found shape of sacral hiatus was the bifid type which is similar to the findings of Nagar SK, Shilpa N Shewale, Malarvani T et al[13] & Clarista MQ & Gautham.[10]

B) Level of Apex of the Sacral Hiatus: According to Strandring et al,[14] the apex of the sacral hiatus is commonly present at the level of 4th sacral vertebra. In our study also we found that majority of the specimens (46.1%) had the apex at the level of 4th sacral vertebra followed by 44.2% specimens showing it at the level of 3rd sacral vertebra. We found 7 sacra which had the apex at the level of 2nd sacral vertebra. The high level of sacral hiatus apex is a dangerous site because of its closeness to the level of dura mater termination at the level of 2nd sacral vertebra. Sekiguchi et al[15] reported apex of sacral hiatus at 1st sacral vertebra in 1% of the cases. In 2009, Kumar et al[16] found the level of apex at 4th sacral vertebra in 76.23% of their cases, Sekiguchi et al, Shilpa N Shewale et al & Seema et al found the same in 64%, 66.5% & 56.36% of their cases respectively.

Authors	Year of study	Location of apex at S4
Trotter & Lanier[17]	1945	63%
Nagar SK[7]	2004	55.9%
Sekiguchi et al[15]	2004	64%
Kumar et al[16]	2009	76.23%
Dr Zarna Patel et al[18]	2011	59.33%
Shilpa N Shewale et al[12]	2013	66.5%
Seema et al[9]	2013	56.36%
Present study	2016	46.1%

Table 8: Comparison of Location of Apex at S4 as found by Various Authors

C) Level of Base of the Sacral Hiatus: In the present study, the base of the sacral hiatus was found at the level of 5th sacral vertebra in 92.3% specimens. This is slightly higher than the findings of Kumar et al (81.17%) in 2009, Vinod Kumar et al (1992) 83.17%, Nagar SK (2004) 72.6% & Seema et al (70.46%). However, Malarvani T et al [13] in their study found that in only 54% of their cases the base was situated at the level of 5th sacral vertebra.

D) Length of the Sacral Hiatus (from its apex to the midpoint of the base): The length of the sacral hiatus was found to be variable in our study. In 46.1% specimens, the length was between 20-30 mm. Kumar et al (2009) observed the mean length of the hiatus as 20 mm in males & 18.9 mm in females. Trotter & Lanier [17] reported the length as 24.8 mm in American males & 19.8 mm in American females. Nagar SK found it to be 11-30 mm in 65.8% specimens. Malarvani T et al found that the length of the sacral hiatus varied from 12 mm to 37 mm in their study. Our findings are quite similar to the findings of the above authors.

E) Antero-Posterior Diameter of Sacral Canal at the Apex of the Sacral Hiatus: The anteroposterior diameter of sacral hiatus at the apex is important as it should be sufficiently wide enough to admit a needle in CEB. In our study, the anteroposterior diameter ranged from 2–12 mm. This matches with the findings as reported by Kumar et al (4.8 mm), Nagar SK (4.8 mm), Sekiguchi et al (6 mm) & Trotter & Letterman[19] (0-11 mm). AP diameter <3 mm was reported in 5.36% of cases by Seema et al & in 8.77% cases by Aggarwal et al. In our study, we found AP diameter <3 mm in only 1 (0.9%) specimen.

F) Width of the Sacral Hiatus at the Base (Inter Cornual Distance): In our study, the intercornual distance varied from 0.4 to 18 mm. In 49% cases, it was between 5-10 mm & in 40.3% cases it was 10-15 mm. These findings are similar to the findings of Vinod Kumar et al (1992) who reported it to be 5-20

mm in males & 8-18 mm in females. Nagar SK found the width at the base to be from 0.3 to 19 mm in his study. However, Malarvani T et al found this distance to be between 7 mm to 27 mm & Trotter et al noted it to be ranging between 7 mm to 26 mm. These values are much higher compared to the present study.

CONCLUSION: The sacral hiatus shows a wide range of variations in terms of length & shape. A knowledge of these anatomical variations will definitely help to increase the success rate of caudal epidural block (CEB) which is often employed to relax the perineal musculature for painless child birth, in orthopaedic practice, in urology, in proctology & in general surgery. This study was undertaken as data regarding variations of sacral hiatus is still underreported from this part of northeast India. Hope, the findings of the present study will fill this gap to certain extent & will be helpful in locating the Sacral Hiatus for a successful CEB.

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