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Original Articles

Morphometric Study of Sacral Hiatus: A Basis for Successful Caudal Epidural Block

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Abstract

Context: *Sacral hiatus is clinically important to caudal epidural block (CEB) in obstetric, orthopedic practice for the treatment of chronic back pain, in urology, proctology and general surgery practice. The reliability and success of CEB depends upon anatomical variations of sacral hiatus. The present study was undertaken to find out the anatomical variations of the sacral hiatus.*

Study type: *Cross-sectional type.*

Place and period of study: *The sacrum were collected from the students of 1st and 2nd year of Jahurul Islam Medical College and Ibrahim Medical College during the period of February, 2012 to June, 2012.*

Materials and Methods: *This study was carried out with 160 dry sacrum of unknown sex. Anatomical measurements were made with a digital caliper.*

Result: *Various shape of sacral hiatus were observed which included inverted U (40%), inverted V (27.6%), irregular (20%), dumbbell shaped (12.5%). The apex and base of sacral hiatus was commonly found at the level of 4th sacral vertebra in 50% and 5th sacral vertebra in 82.5% accordingly. The mean length of sacral hiatus was 23.61 mm. The Anteroposterior diameter at the level of apex ranged from 2mm to 9 mm with a mean of 5.34 mm and the mean transverse diameter at the level of base was 12.75 mm. Average distance between sacral apex to level of S2 (sacral-2) foramina was 31.3 (10.6) mm (range 5-60 mm) and distance between sacral base to level of S2 (sacral-2) foramina was 54.9 (7.9) mm (range 37-79 mm).*

Conclusion: *From the study it can be concluded that there are variations in the shape and the level of the hiatus.*

Key words: *Sacral hiatus, Caudal epidural block.*

Introduction:

Sacrum is a large, triangular fusion of five vertebrae and forms posterosuperior wall of pelvic cavity, wedged between two hip (innominate) bones. The triangular sacral canal is formed by sacral vertebral foramina[1]. The opening present at the caudal end of sacral canal is known as sacral hiatus. It is formed due to the failure of fusion of the fifth (occasionally 4th) sacral vertebra. It is located inferior to the 4th (or 3rd) fused sacral spines or lower end of median sacral crest[2]. The remnants of the inferior articular process elongate downwards on both sides of the sacral hiatus. These two bony processes are called the sacral cornua (horns) and define important clinical landmarks during caudal epidural block (CEB)[3]. Sacral hiatus is identified by palpation of sacral cornua. Sacral cornua are felt at the upper end of natal cleft 5 cm above the tip of the coccyx[2].

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Sacral hiatus contains lower sacral and coccygeal nerve roots, filum terminale externa and fibro fatty tissue. In recent state, the hiatus is covered by superficial posterior sacrococcygeal ligament which is attached to the margins of the hiatus and deep posterior sacrococcygeal ligament attached to the floor of the sacral hiatus. Distal most portion of the dural sac terminates between levels S_1 and S_3.

Reliability and success of CEB depends upon anatomical variations of sacral hiatus as observed by various authors[4,5,6]. CEB has been widely used for the treatment of lumber spinal disorders and also for the management of chronic back pain[7,8,9]. Sacral hiatus functions as a landmark when caudal anesthesia is administered in urology, proctology, general surgery and obstetrics and gynecology practice[10]. The present study was undertaken to find out the anatomical variations of sacral hiatus which will be useful for caudal epidural anesthesia.

Materials and Methods:

The materials for the present study consist of 160 adult sacrum of unknown sex. These were collected from the students of 1st and 2nd year of Jahurul Islam Medical College, Bajitpur, Kishoreganj and Ibrahim Medical College, Dhaka. The measuring was done on intact parts of normal bones. Bones showing wear and tear, fracture or any pathology were not considered. Each sacrum was studied with regards to:

1. Shape of sacral hiatus
2. Level of apex of sacral hiatus
3. Level of the base of sacral hiatus
4. Length of the sacral hiatus-measured from apex to midpoint of base
5. Antero posterior diameters (depth) of sacral canal at the level of apex
6. Transverse diameters (width) at the level of cornua
7. Distance from the apex of sacral hiatus to the level of S2 foramina
8. Distance from base of sacral hiatus to the level of S2 foramina

The measurements were taken with help of digital caliper. Statistical calculation was done by using SPSS software.

Observations and results:

Table-I

Shape of the sacral hiatus (n=160)

Sl. No	Shape	No. of specimen	Percentage (%)
1.	Inverted U-shaped	64	40
2.	Inverted V-shaped	44	27.6
3.	Irregular	32	20
4.	Dumbbell shaped	20	12.5

Table-II

Level of apex and base of the sacral hiatus (n=160)

Level of vertebra	Apex		Base	
	No.	%	No.	%
Sacral 4th	80	50	14	8.7
Sacral 3rd	72	45	-	-
Sacral 5th	8	5	132	82.5
Coccyx	-	-	14	8.7

Table III

Length of sacral hiatus from apex to midpoint of base (n=160)

Sl. No.	Length in mm	No.	Percentage	Mean ± SD (mm)
1.	0-10	10	6.3	23.61 ± 8.28
2.	11-20	56	35	
3.	21-30	74	46.3	
4.	31-40	16	10	
5.	41-50	2	1.3	
6.	> 51	2	1.3	

Table-IV

Transverse diameter (width) at the level of cornua (n=160)

Sl. No.	Transverse width in mm	Number	Percentage	Mean ± SD(mm)
1.	0-5	2	1.2	12.75 ± 2.92
2.	6-10	46	28.7	
3.	11-15	90	56.2	
4.	>16	22	13.3	

Table-V

Anteroposterior diameter (depth) of sacral canal at the level of apex (n=160)

Sl. No.	Diameter in mm	No.	Percentage	Mean ± SD (mm)
1.	0-3	22	13.7	5.34 ± 1.39
2.	4-6	120	75	
3.	7-9	18	11.2	

Table VI

Distance between apex to level of S2 foramina and base to level of S2 foramina (n=160)

Measurement parameter(mm)	Mean ± SD	Minimum	Maximum	Median
Apex to S2 foramina	31.33 ± 10.59	5.02	60.3	28.91
Base to S2 foramina	54.88 ± 7.92	37.03	79.8	54.06

Observations and Results:

Hiatus of various shapes was identified (Table-I).In 64 (40%) sacra the shape was inverted U (Fig.-2), in 44 (27.6%) sacra were inverted V (Fig-3), in 32 (20%) sacra were irregular (Fig.-4), in 20 (12.5%) sacra were dumbbell (Fig.-5).

Level of apex of sacral hiatus varied from S3 to S5. It was as high as S3 in about 72 (45%) sacra and was located most commonly against S4 in 80 (50%) sacra. (Table II)

Base of the hiatus was most commonly located at S5 in 132 (82.5%) sacra. In 14 (8.7%) sacra base lies at coccyx and also in 14 (8.7%) sacra at S4 level (Table II).

The length of the sacral hiatus ranged between 6 mm to 51 mm with a mean of 23.61 mm. In 74(46.3%) sacra length ranged between 21mm to

Fig.-1: *ab-Distance between apex to level of S2 foramina, ac-Distance between base to level of S2 foramina, bc-length of sacral hiatus, de-transverse diameter of sacral hiatus*

Fig.-2: *Inverted U-shaped hiatus*

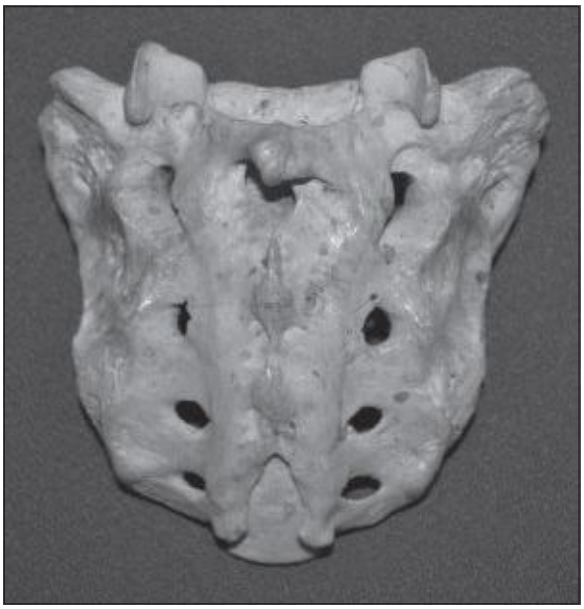

Fig.-3: *Inverted V-shaped hiatus*

Fig.-4: *Irregular hiatus*

30 mm and in 56 (35%) sacra length ranged between 11 mm to 20 mm (Table III).

The width of hiatus varied from 5 mm to 21 mm with a mean of 12.75 mm. In 90 (56.2%) sacra it was 11-15 mm and in 46 (28.7%) sacra it was 6-10 mm. (Table IV)

Anteroposterior diameter of sacral canal at the level of apex ranged from 2 mm to 9 mm with a mean of 5.34 mm. It was 4-6 mm in 120 (75%) sacra, 0-3 mm in 22(13.7%) sacra and 7-9 mm in 18 (11.2%) sacra. (Table V):

Average distance between sacral apex to level of S2 foramina was 31.3 (10.6) mm (range 5-60 mm) and distance between sacral base to level of S2 foramina was 54.9 (7.9) mm (range 37-79 mm (Table VI and Figure 1)

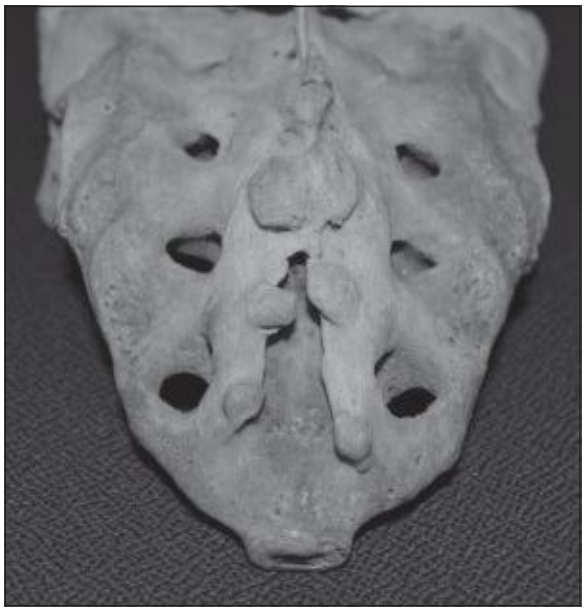

Fig.-5: *Dumbbell shaped hiatus*

Discussion:

Study on the variation in anatomical features of sacral hiatus and the dorsal wall of sacral canal is related with regards to its clinical application in caudal epidural block in perineal surgery and for painless delivery.

In the present study, the shapes of sacral hiatus were variable. Sacral hiatus was inverted U in 64 (40%) sacra and inverted V in 44 (27.6%) sacra and dumbbell in 20 (12.5%) sacra, which were similar to Nagar SK[11]. In 32 (20%) sacra the shape was like irregular which was very high when compared to Nagar S. K.[11], Anjali[12] and Suma et al[13]. Vinod Kumar et al[6] also noted various shapes of sacral hiatus, most common being inverted V in 94 (46.53%) and inverted U in 60 (29.70%).

Apex of the sacral hiatus was seen most commonly at the level of 4th sacral vertebra in 80 (50%) sacra,

which was almost similar to Nagar SK[11] who reported it in 147 sacra (55.9%). Sekiguchi M et al[4] found this level in 60 (65%) and Vinod Kumar et al[6] in 154 (76.23%) sacra. All studies including the present study noted that location of apex can vary from upper part of 3rd sacral vertebra to 5th sacral vertebra.

In the present study, base of the sacral hiatus was seen at the level of 5th sacral vertebra in 132 (82.5%) sacra which was almost similar to Zarana et al[14] who found it in 119 (79.33%) and Vinod Kumar et al[6]. But Nagar SK[11] who noted it in 191 (72.6%) sacra out of 270 bones studied.

The length of sacral hiatus ranged between 6 mm to 51 mm and in about 74 sacra (46.3%), it was 21-30 mm and mean length was 23.16 mm in the present study. Vinod Kumar et al[6] observed mean length of hiatus as 20 mm in male and 18.9 mm in female. Trotter et al[15] have reported hiatal length as 24.8 mm in American male and 19.8 mm in female.

Anteroposterior depth of sacral canal at apex of sacral hiatus is important as it should be sufficiently large to admit a needle. In the present study, the anteroposterior depth ranged from 2 mm to 9 mm with a mean of 5.34 mm. Arithmatic mean of anteroposterior depth reported by various workers are similar like Trotter et al (1944)[16] who found 5.3 mm (range of 0-11 mm). Lanier et al[17], observed 6.1 mm ± 0.2 mm, Trotter et al[5], reported 5 mm in Whites and 6 mm in Negro groups, Vinod Kumar et al[6], found 4.8 mm and Sekiguchi M et al[4], recorded 6.0 ± 1.9 mm, antero posterior depth.

In the present study anteroposterior depth of sacral canal at apex of sacral hiatus between 4-6 mm was seen in 120 (75%) bones which was similar to Nagar SK[11] who observed in 169 (64.2%) sacrum bones.

The transverse diameter at the base of sacral hiatus varied from 5 mm to 21 mm, in 56.2% cases it was 11-15 mm with a mean of 12.75 mm. This was almost similar to earlier studies like Vinod Kumar et al[6] who reported 5-20 mm (13 in mean). Senoglu N et al[7] found the transverse diameter from 7-28 mm with a mean of 17.47 mm.

An important point in CEB is awareness of the distance between the sacral hiatus and dural sac anatomically in relation to the risk of dural puncture. The dimensions of sacral hiatus may vary. In the present study we used the level of S2 (dural sac usually terminates at S2 in adults). The distance between the S2 foramen and the apex of the sacral hiatus was 31.33 mm on an average (range 5-60 mm) and distance to the base of the sacral hiatus was 54.88 mm (range 37-79 mm). It has been reported by Senoglu N et al[7] that the distance between the S2 foramen and the apex of the sacral hiatus was 35.37 mm on an average (range 11-62 mm) and the distance to the base of the sacral hiatus was 65.25 mm (range 39-85 mm).

Conclusion:

Apex of sacral hiatus is an important landmark for carrying out successful caudal epidural block. Thus, exact localization of the sacral hiatus would certainly help in the easy passage of needle into the sacral canal. Variations in the shape and level of the hiatus may lead to failure of CEB. This study will be helpful to the clinicians in determining the location of the sacral hiatus during CEB.

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