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Original Research Article

THE STUDY ON MORPHOLOGICAL AND MORPHOMETRIC ANALYSIS OF SACRAL HIATUS IN DRY HUMAN SACRA

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ABSTRACT

This study was carried out on 80 dry human sacra in meenakshi medical college Anatomical variations in morphology and morphometry of sacral hiatus. Various shapes of sacral hiatus were observed which included inverted U (66.3%), inverted V (11.3%), irregular (11.3%), dumbbell (3.8%) Agenesis Of the dorsal (6.3%) and bifid (1.3%). The apex of sacral hiatus was commonly found at the level of 4th sacral vertebra in 76.0%. the mean length of sacral hiatus was 22.9 mm. The mean anteroposterior diameter of sacral canal at the apex of sacral hiatus was 4.97 mm. Narrowing of sacral canal at the apex of sacral hiatus, diameter less than 4mm, was observed to be significantly high, (36%). The knowledge of anatomical variations of sacral hiatus is significant while administration of caudal epidural anaesthesia and it may help to improve its success rate.

KEY WORDS: Sacral Hiatus, Apex, Caudal Anaesthesia.

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INTRODUCTION

The sacrum is wedge-shaped bone and is composed of five fused sacral vertebrae in adults. It is located between the hip bones and forms the roof and postero-superior wall of the posterior half of the pelvic cavity. The triangular shape of the sacrum results from the rapid decrease in the size of the inferior lateral masses of the sacral vertebrae during development. The inferior half of the sacrum is not weight-bearing; therefore, its bulk is diminished considerably. The sacrum provides strength and stability to the pelvis and transmits the weightof the body to the pelvis and pelvic girdle, the bony ring formed by the hip bones and sacrum, to which the lower limbs are attached.

The base of the sacrum is formed by the superior surface of the S1 vertebra. The apex of the sacrum has an oval facet for articulation with the coccyx. The sacrum is often wider in proportion to length in the female than in the male, but the body of the S1 vertebra is usually larger in males. The pelvic surface of the sacrum is smooth, concave and has four transverse lines on this surface indicate the fusion of the sacralvertebrae which are connected by hyaline cartilage and separated by intervertebral discs [1,2].

The dorsal surface of the sacrum is rough, convex, and marked by five prominent longitudinal ridges. The central ridge, the median sacral crest, represents the fused rudimentary spinous processes of the upper three or four sacral vertebra and S5 vertebra has no spinous process. The intermediate sacral crests are the fused articular processes and the lateral sacral crest are the tips of the transverse processes of the fused sacral vertebrae.

The clinically important features of the dorsal surface of the sacrum are the inverted U –shaped sacral hiatus and the sacral cornua. Below the fourth (or third) tubercle there is an arched sacral hiatus in the posterior wall of the sacral canal. This hiatus is produced by failure of fusion of the lamina of the fifth sacral vertebra, and as a result the posterior surface of the body of S5 vertebra is exposed on the dorsal surface of the sacrum. The sacral cornua, representing the inferior articular process of S5 vertebra, project inferiorly on each side of sacral hiatus and are a helpful guide to its location [3]. The sacral cornua is connected to the coccygeal cornua by intercornual ligaments. This hiatus is closed by fibrous tissue forming the superficial ligaments. The sacral canal is the continuation of the vertebral canal in the sacrum which is triangular in cross-section and curves with the sacrum. The sacral canal contains the meninges which extend down to S2 vertebra. From here the filum terminale (pia mater), piercing the dura, runs down to blend with the periosteum on the back of the coccyx. The space around the dura mater and its prolongation is filled with loose fat and the internal vertebral venous plexus. The sacral canal contains the bundle of spinal nerve roots arising inferior to the L1 vertebra, known as the cauda equina (L. horse tail).The lower opening of the sacral canal is called sacral hiatus. It transmits the 5th pair of sacral nerves, coccygeal nerves & filum terminale externa [4]. The two-bony process on either side of sacral hiatus are known as sacral cornua. It is very important landmark to locate the sacral hiatus.

MATERIALS AND METHODS

The study was done in 80 dry human sacra in the Department of Anatomy at Meenakshi Medical College & Research Institute Kanchipuram Tamil Nadu. 80 dry human sacra were collected from various medical institutions of muthukumaran medical college and meenakshi medical college. Each sacrum was studied for different features of sacral hiatus with regards to:

It is a morphological and morphometric study of sacral hiatus.

1. The different shape of the sacral hiatus were noted

2. The level of the apex of hiatus

3. The level of the base of hiatus

4. The length of the hiatus was measured from apex to midpoint of the base

5. The antero-posterior diameter of the sacral hiatus at the apex

6. The transverse width of the sacral hiatus at the base was measured between the inner aspect of inferior limit of sacral cornu.

The measurements were taken with the help of vernier calliper, divider and steel measuring tape.

OBSERVATIONS AND RESULT

Table 1: Shape of sacral hiatus (n =80).

Sl. No	Shape	No	percentage
1	Inverted u	53	66.30%
2	Inverted v	9	11.30%
3	Irregular	9	11.30%
4	Agenesis of the dorsal	5	6.30%
5	Dumbbell	3	3.80%
6	Bifid	1	1.30%

In 5 sacra there was complete agenesis of the dorsal bony wall of sacral canal (6.3%). In 2 sacra sacral hiatus was absent (0.7%). In one, the sacral hiatus was less then 6 mm (0.4%).

These five sacra were excluded from the measurements as typical sacral hiatus was not present in them.

Table 2: Location of apex in relation to level of sacral vertebra (n = 75).

Sl.No	Locations of Apex	No	No. Percentage
1	2nd Sacral vertebra	1	1.30%
2	3rd Sacral vertebra	16	21.30%
3	4th Sacral vertebra	57	76.00%
4	5th Sacral vertebra	1	1.30%

Table 3: Location of base of hiatus in relation to sacral / Coccygeal vertebra (n = 75).

Sl.No	Location of base	No	Percentage
1	4th Sacral vertebra	1	1.30%
2	5th Sacral vertebra	74	98.70%
3	Total	75	100.00%

Table 4: Length of sacral hiatus from apex to midpoint of base.

Sl.No	Length	No	Percent
1	1 to 10 mm	3	4
2	11 to 20 mm	26	34.7
3	21 to 30 mm	35	46.7
4	31 to 40 mm	11	14.7

Table 5: The antero-posterior diameter of sacral hiatus.

Sl.No	Length	No	Percentage
1	1 to 4 mm	27	36.00%
2	5 to 6mm	43	57.30%
3	7 to 8mm	5	6.70%

Table 6: The transverse diameter of sacral hiatus.

Sl.No	Length	No	Percentage
1	10 to 15 mm	14	18.7
2	16 to 20 mm	55	73.3
3	21 to 25 mm	6	8

The shape of the sacral hiatus:

Fig. 1: Inverted "U" shaped

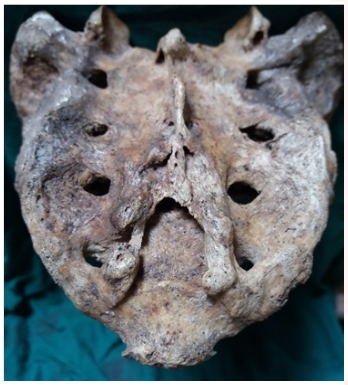


Fig. 2: Inverted "V" shaped

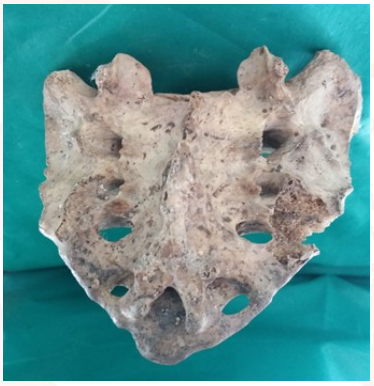


Fig. 3: Irregular shaped

Fig. 4: Dumb Bellshaped

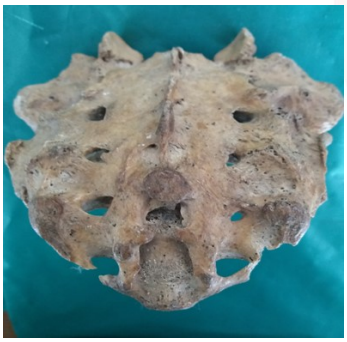


Fig. 5: Bifid

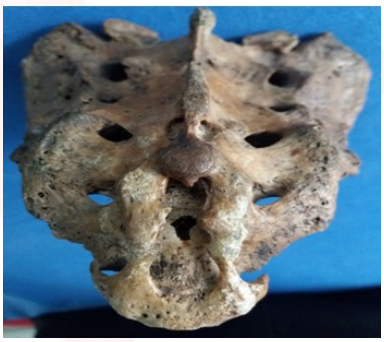
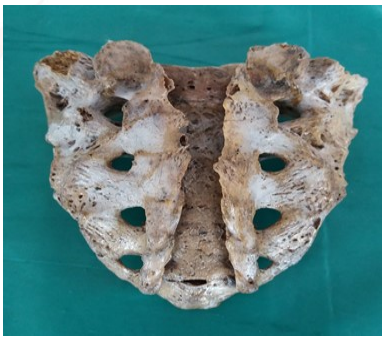


Fig. 6: Agenesis of dorsal wall



DISCUSSION

The sacrum has a base, apex and three surfaces are Pelvic, dorsal and lateral surfaces. The dorsal surface of the sacrum is convex and has median sacral crest. The sacral canal is a continuation of the spinal canal and runs throughout the greater part of the sacrum. The failure of the fusion of the lamina of the fifth sacral vertebra or sometimes fourth sacral vertebra resulting the sacral hiatus.

The present study was done on the shape of the sacral hiatus, the level of the apex, base of the hiatus and the length and width of the hiatus. Regarding agenesis of sacral hiatus Senoglu observed in six sacra, VijishaPhalgunan [5] observed in two specimens, Silpa Nilesh Shewale [6] in two specimens, Ashraf y nasar [7] in four specimens and Dr. Simriti [8] observed spina bifida in four sacra. In the present study the agenesis or complete spina bifida was observed in five sacra and were excluded from the study. Regarding the composition of sacra Shabanam Arora [9] observed as five segments, four segments and six segments and in the present study five segments in 79 specimens and four segments in one specimen were observed. Vijay kumar shinde [10] observed variations of sacral hiatus in 2% of his study in which the hiatus was

Table 7: Comparative study of shape of the sacral hiatus.

S.No	Authors	Inverted "u"	Inverted "v"	Irregular	Dumm bell	Bifid
1	Nagar S.K et al.	41.5	27	14.1	13.3	1.5
2	Clarista M.Q. et al.	46.2	24	-	-	-
3	Seema et al.	42.95	27.51	16.1	11.4	2.01
4	ShilpaNilesh, et al.	40.69	32.35	-	-	-
5	Dr.Qudusia sultana et al.	62.37	22.16	8.76	3.9	1.54
6	Shabana et al.	29.4	22.47	-	-	2.24
7	Nadeem et al.	56	14	16	10	-
8	Dona saha et al.	70.09	14.53	12.82	0.85	1.71
9	Rubisaikia et al.	53.8	29.8	9.6	5.7	0.9
10	Present study	66.3	11.3	11.3	3.8	1.3

Table 8: Comparative morphometric study of sacral hiatus.

Sl. No	Authors	Length of sacral hiatus from apex to base	The transverse width of sacral hiatus	The anteroposterior diameter of sacral hiatus
1	Nagar S.K et al.	22.8	-	4.88
2	Clarista M.Q. et al.	-	-	5.58
3	Seema et al.	22.69	-	6.49
4	Dr.Qudusia sultana et al.	23.29	15.9	4.97
5	Dona saha et al.	20.21	12.1	-
6	Irungbam Devensingh et al.	18.97	11.15	4.67
7	Present study	22.97	17.36	4.97

closed leading to absent hiatus. Hence it is impossible for giving caudal anesthesia .In the present study absence of hiatus was not observed.

The shape of the sacral hiatus: In the present study there were six types of sacral hiatus like inverted "U", inverted "V", irregular, dumb bell, bifid types and agenesis were observed (fig 1a-1f) (Table :1)

Inverted "U" shaped hiatus: Regarding inverted "U" shaped sacral hiatus was observed by Dr. Qudusia sultana in 62.37% and Dona in 70.1% of specimens [11,12]. In the present study it was observed in 66.3% of specimens which is almost similar to the previous studies.

Inverted "V" shaped hiatus: The inverted "V" shaped hiatus was observed by Dona saha in 14.53% and by Nadeem in 14% [13] of specimens. In the present study it was observed in 11.3% of specimens which is similar to the previous studies.

Irregular shaped sacral hiatus: Irregular shaped hiatus was observed by Nagar in 14.1% [14] and by Dona in 12.82% of their specimens and in the present study it was in 11.3% of specimenswhich is almost of specimens which is almost similar to the previous studies.

Dumbbell shaped sacral hiatus: Dumbbell shaped hiatus was observed in 3.9% specimens by Dr. Qudusia sultana and in the present study it was in 3.8% of specimens.

Bifid shaped hiatus: Bifid shaped hiatus was observed by Nagar in 1.5% and by Dr. Qudusia sultana in 1.54% of their specimens. In the present study it was in 1.3% of specimens which is similar to the above studies (Table: 1). Shabnam Arora[9] et al observed "M" shaped sacral hiatus in their study but in the present study the "M" shape was not observed [15].

Apex of the sacral hiatus: Jeewanjotsekhon [9] observed the apex of the sacral hiatus was commonly present at the level of fourth sacral vertebra and base was at the level of fifth sacral vertebra. Dr. Qudusia sultana [11] noted the level of the apex of hiatus was at fourth sacral vertebra in 74.21% specimens. AshokK.R [17] observed apex of hiatus at the level of fourth sacral vertebra in 57.40%, at third sacral vertebra in 35.18%, at second sacral vertebra in 5.55% and at fifth sacral vertebra in 1.85% of specimens. In the present study the apex of hiatus was at the level of fourth sacral vertebra in 76%, third sacral vertebra in 21.3%, second sacral vertebra in 1.3% and fifth sacral vertebra in 1.3% of specimens which were almost similar to the previous studies.

Base of the sacral hiatus: In the present study the location of the base of sacral hiatus was present at the level of fifth sacral vertebra in 98.7% and at the level of fourth sacral vertebra in 1.3% of sacra which was similar to the previous study of Clarita M.Q [18] in 95.8%, Dr. Qudusia sultana in 96.84% and by Dona in 95.73% [12] of specimens.

Length of sacral hiatus: The length of the sacral hiatus was measured from apex to the midpoint of the base of the sacral hiatus [19]. In the present study the mean length of the sacral hiatus was 22.97mm which is similar to the previous studies by Nagar the length was 22.8 mm, Seema 22.69mm [20], by shabnam Arora the length was 23.29mm (Table 2).

Antero-posterior diameter of the sacral hiatus: In the present study the mean antero-posterior diameter of the sacral hiatus was 4.97mm which was similar to the previous studies by Nagar 4.8mm [14], Shabnam Arora 4.97 and Irungbam [21] the diameter was 4.67mm (Table 2).

The transverse diameter of the sacral hiatus: In the present study the mean transverse diameter at the level of base was observed as 17.36mm which was almost similar to the previous study of Shabnam Arora was 15.90 ±2.38mm. (Table 2) The anatomical variations of sacral hiatus are very important to do the caudal epidural anesthesia [9] used in operations [22] in the anal region, external genital organs as well as cystoscopic examination in male and continuous caudal epidural anesthesia is used in obstetrics during parturition for shortening the labour [23].

The success rate of caudal epidural anesthesia depends on the normal anatomy of the sacral hiatus

CONCLUSION

The knowledge of anatomical variations of sacral hiatus is significant while giving caudal epidural anesthesia which helps to improve the success and reduces the incidence of complications. Sacral cornua is an important bony land mark to locate the sacral hiatus during caudal epidural anesthesia. The length of the sacral hiatus is too long is not favorable for caudal epidural anesthesia because it may lead to puncture of the dural sac. Variation in the anatomy of the sacral hiatus is one of the reason for the failure of caudal epidural block. The variation also leads a problem in transpedicular or lateral mass screw placement in the sacrum. The Clinician should be aware of the chances of agenesis of sacral hiatus or complete spina bifida while performing any procedure.

The precise knowledge of normal and abnormal anatomy of the sacral hiatus are clinically important for the anesthetist, neurologist, radiologist and orthopedic surgeon in the clinical practice.

Conflicts of Interests: None

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