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Research Article

Study of dorsal wall of sacrum

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ABSTRACT

Background: Sacrum is a large triangular bone formed by fusion of five sacral vertebrae. The opening present at the caudal end of sacral canal is known as sacral hiatus and is formed due to the failure of fusion of lamina of fifth sacral vertebra. Objective of current study was to study the anatomical variations of dorsal wall of sacrum in order to clarify the structural variations of sacral hiatus and surrounding structures for improving the reliability of caudal epidural block
Methods: The present study was done on 50 male and 50 female dry human sacra after calculating the sacral indices and sexing of sacra. The dorsal wall of sacrum was studied with respect to composition of sacrum, level of sacral hiatus, deficiencies and apertures in the bony dorsal wall and also for the presence and absence of sacral cornua.
Results: The level of apex of sacral hiatus can vary from upper part of S2 to lower part of S5. The most common position was at S4 (64%). Elongated sacral hiatus at the level of S2 was present in 4% of cases. Sacrum had normal 5 segments in 70% of cases, 4 segmented sacra were observed in 4% of cases, sacralization of 5th lumbar vertebra in 7%, coccygeal ankylosis in 19% of cases. Less extensive apertures in the bony dorsal wall of sacral canal were observed in 29% of sacra.
Conclusion: The dorsal wall of sacrum has anatomical variations. Understanding these variations may improve the reliability and success of caudal epidural anesthesia.

Keywords: Sacrum, Sacral hiatus, Caudal epidural anesthesia

INTRODUCTION

Sacrum is a triangular bone formed by fusion of five sacral vertebrae. It is inserted as a wedge between the two innominate bones at the upper and posterior part of pelvic bone. 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 laminae of the fifth (occasionally 4th) sacral vertebra.[1]

The variations in the structure of dorsal wall of sacral canal are numerous. It may be open throughout its entire length or there may be low lying lamina of first sacral vertebra. Other variations include deficiencies between its superior and inferior limits, obliteration of lumen of sacral canal and bony overgrowth obliterating the hiatus. The presence of any apertures may permit the needle to escape the canal resulting in subcutaneous deposition of anesthetic agent.[2]

Caudal epidural anesthesia involves injections of medications into the epidural space through the sacral hiatus to provide analgesia and anesthesia in various clinical settings. It was first performed in 1900. The introduction of continuous caudal analgesia in obstetrics by Edward and Hingson in 1942 has revived the interest of clinicians in the anatomy of sacrum and its related structures. This interest on the part of clinicians has stimulated anatomists to make a more detailed study of sacral region and to evaluate the incidence of variations

and malformations in their relationship to clinical technical difficulties encountered by the surgeon.[2]

CEB is widely used in orthopedics, urology, proctology and general surgery apart from obstetrics for the diagnosis and treatment. Hence a thorough knowledge of the anatomical features in the dorsal region of sacrum in male and female sex will inevitably lead to the reduction in the number of failures of the skilled clinician in the administration of caudal analgesia. The present study is undertaken to clarify the anatomic variations of sacral hiatus in male and female sex which may help for improving the reliability of caudal epidural block.[3]

The presence of unusually large hiatus may prove dangerous to life, owing to the risk of puncturing the dural sac and making an intradural injection. The complete agenesis of the dorsal wall may be one of the rare contraindication to CEB because of the possibility of puncturing the dura.[4]

Clinicians may experience difficulties in palpating the Sacral hiatus hence other prominent anatomical landmarks such as triangle formed between posterior superior iliac spines and the apex of sacral hiatus which forms an equilateral triangle will be of use. Some believe that sacral cornua act as the consistent landmark for the sacral hiatus [13]. This practical guide will be of benefit to the clinician in determining the location of sacral hiatus and increases the success rate of CEB.[5]

METHODS

The present study was conducted in the department of anatomy, Kempegowda institute of medical sciences, Bangalore, Karnataka.

The study was done on 50 male and 50 female dry, complete undamaged human sacra. Sexing of sacrum was done by calculating the sacral index.

$$\text{Sacral index} = \frac{\text{Maximum breadth x 100}}{\text{Maximum height}}$$

1. The maximum height of sacrum: the straight distance from sacral promontory in the mid sagittal plane to the corresponding lowest point on the anterior margin of the sacrum by dial caliper.

2. The maximum breadth of sacrum: the straight distance between two points at the lateral most point of the ala of the sacrum by dial caliper

According to the measured sacral indices sacra were divided into 2 groups depending upon the gender. Sacra with sacral indices <105 were considered as male sacra whereas sacra with SI >115 were considered as female sacra. Sacra with SI between 105 and 115 were not considered.

Various parameters of each sacrum were studied and recorded separately in male and female sacrum under the following headings:

1. Level of apex of sacral hiatus was noted with respect to sacral vertebra

2. Sacral composition

3. Presence and absence of sacral cornua

4. Deficiencies in the dorsal wall of sacrum

RESULTS

The level of apex of sacral hiatus can vary from upper part of S2 to lower part of S5. The most common position was at S4 (64%). Elongated sacral hiatus at the level of S2 was present in 4% of cases. Sacrum had normal 5 segments in 70% of cases, 4 segmented sacra were observed in 4% of cases, sacralization of 5th lumbar vertebra in 7%, coccygeal ankylosis in 19% of cases.

In the present study normal sacral cornua on both sides were present in 58% and unilateral cornua in 26%. Sacral cornua was absent in 12% of cases. Less extensive apertures in the bony dorsal wall of sacral canal were observed in 29% of sacra with preponderance to male group in our study**.** Such variations included low lying lamina of first sacral vertebra (7%), unilateral and bilateral midline deficiencies (22%) between the extremities of the dorsal wall. The collective percentage of these deformities was as high as 25.24%.

Table 1: Level of apex of sacral hiatus with respect to sacral vertebra.

Level of apex of sacral hiatus	Male	Female	N=100
Level of apex of sacral hiatus at S2	02	02	04%
Level of apex of sacral hiatus at S3	07	10	17%
Level of apex of sacral hiatus at S4	31	33	64%
Level of apex of sacral hiatus at S5	06	05	11%
Complete spina bifida	03	00	03%
Absent hiatus	01	00	01%

Table 2: Sacral composition.

Sacral composition	Male	Female	N=100
5 segment sacra	35	35	70%
4 segment sacra	00	04	04%
Sacralization of 5th lumbar vertebra	07	00	07%
Coccygeal ankylosis	08	11	19%

Table 3: Presence or absence of sacral cornua.

Sacral cornua	Male	Female	N=100
Bilateral sacral cornua	30	28	58%
Unilateral sacral cornua	10	16	26%
Absent sacral cornua	10	06	16%
Deficiencies in the dorsal wall	19	10	29%

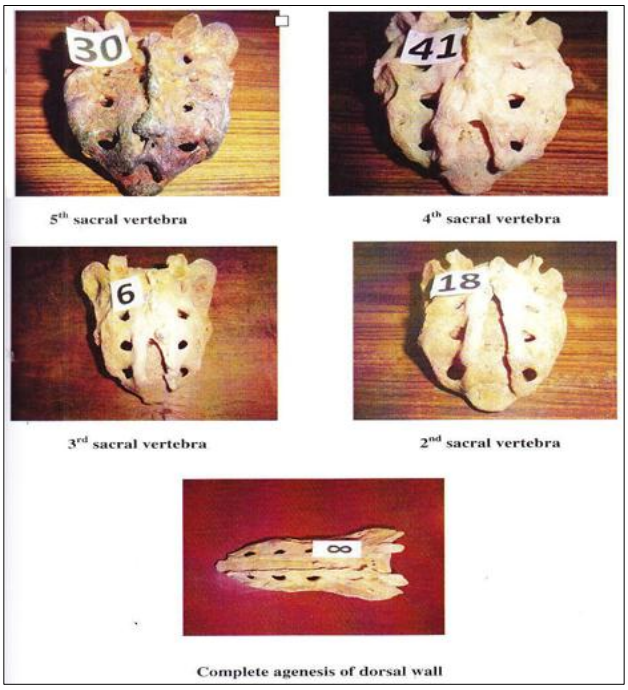

Figure 1: Levels of apex of sacral hiatus with respect to sacral vertebra.

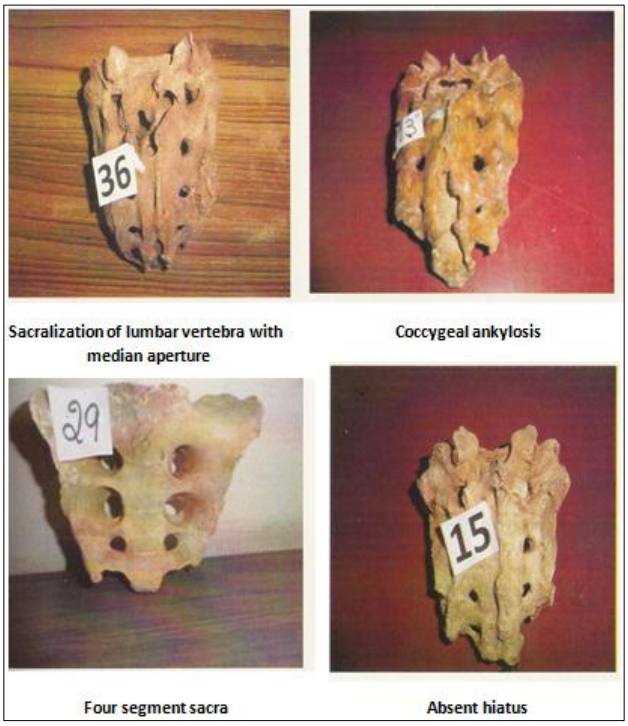

Figure 2: Sacral composition.

DISCUSSION

The common location of level of apex of sacral hiatus was found to be 4th sacral vertebra (64%) followed by 3rd sacral vertebra in both male and female sacrum. This is compared with the study done by Trotter and Letterman in Table 5. There was complete agenesis of sacral hiatus in about 3% of sacra all were of male sacra. This is higher to that reported by previous workers namely Trotter 1.8%, Vinod Kumar[6] 1.49%, Nagar SK[3] 1.5%. Absent sacral hiatus which is a rare phenomenon was observed in one male sacra as compared to Nagar 0.7%, Vinod Kumar 0.99% and Seikiguchi[8] M 3%. The caudal analgesia is feasible even in complete sacral spina bifida since the dorsal wall of sacral canal is completed by ligaments. However absent sacral hiatus will make the caudal block impossible. In cases of much elongated sacral hiatus there is always risk of puncturing the dural sac in caudal block as the apex is invariably close to lower end of dural sac.[6]

In the present study, sacrum had normal 5 segment composition in 70% of cases; four segmented sacra were observed in 4% of cases, sacralization of 5th lumbar vertebra in 7%, coccygeal ankylosis in 19% of cases. These findings were almost similar to the observations made by Vinod Kumar as tabulated below. All these study confirms that the incidence of coccygeal ankylosis to be much greater than sacralization of 5th lumbar vertebra.in the present study four segmented sacra were observed in 4% of cases all were female, perhaps this trend may be an evolutionary change in reduction of vertical dimension of female pelvis to fecilitate labour.

Sacral cornua act as important landmark to identify the sacral hiatus During CEB. In the present study normal sacral hiatus was present in 58% and unilateral cornua in 26% which is almost similar to the observations made by Black but different from that of Seikiguchi that might influence the palpation of sacral hiatus.

Table 4: Level of apex of sacral hiatus.

Level of apex of sacral hiatus	Vinod Kumar	Seikiguchi	Nagar SK	Present study
S2	4.95%	4%	3.4%	4.1%
S3	8.91%	15%	37.3%	17.7%
S4	76.23%	65%	55.9%	66.6%
S5	7.43%	15%	3.4%	11.45%
Complete spina bifida	1.49%	-	1.5%	3%
Absent hiatus	0.99%	-	1.1%	1%

Less extensive apertures in the bony dorsal wall of sacral canal were observed in 29% of sacra with preponderance to male group in our study which is almost similar to the study conducted by trotter where he observed such apertures in 25% of sacra with male preponderance. Such variations included low lying lamina of first sacral

vertebra (7%), unilateral and bilateral midline deficiencies (22%) between the extremities of the dorsal wall. The collective percentage of these deformities was as high as 25.24%. These apertures in the dorsal wall of sacral canal though closed by ligaments, may provide an escape for the tip of needle leading to subcutaneous infusion.

Table 5: Sacral composition.

Sacral composition	Vinod Kumar	Trotter & Lanier	Present study
5 segment	69.8%	47.7%	70%
4 segment	1.48%	0.7%	4%
Sacralization of 5th lumbar vertebra	7.43%	12.6%	7%
Coccygeal ankylosis	21.29%	39.3%	19%

Table 6: Sacral cornua.

Sacral cornua	Seikiguchi	Black	Present study
Bilaterally present	21%	52%	58%
Unilaterally present	29%	17%	26%
Absent	50%	31%	16%

CONCLUSION

The dorsal wall of sacrum has anatomical variations. Understanding these variations may improve the reliability and success of caudal epidural anesthesia. At the end of the study all the objectives were accomplished. The following important inferences were drawn from the present study:

1. In elongated sacral hiatus there is always danger of puncturing the dural sac in caudal block as the apex is invariably close to lower end of dural sac.
2. Absence of sacral hiatus will make the caudal block impossible.
3. Apertures in the dorsal wall of sacral canal though closed by ligaments, may provide an escape for the tip of the needle leading to subcutaneous infusion.
4. Absence of sacral cornua poses difficulty in locating the sacral hiatus.
5. Sacralization of lumbar vertebra is frequently associated with low back pain, disc herniation.
6. Four segmental sacra were observed only in female sacra; perhaps this trend may be an evolutionary change in the reduction of vertical dimension of female lesser pelvis to facilitate labour.

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