

Research article

Sacral Hiatus Study in Dry Human Sacra

Mishra M¹, Singh AK¹, Jha S², Satyavathi P³, Sah N¹

Department of Anatomy
Pratima Institute of Medical Sciences, Karimnagar, Andhra Pradesh, India

¹Department of Anatomy, Janaki Medical College, Janakpur, Nepal

²Department of Physiology, Janaki Medical College, Janakpur, Nepal

³Department of Anatomy, Pratima Institute of Medical Sciences, Karimnagar, Andhra Pradesh, India

ABSTRACT

Background and objectives: The sacral hiatus is the site for caudal epidural anaesthesia during perineal surgery and also for a painless delivery. It is also used for three dimensional colour visualization of lumbosacral epidural space in orthopaedic practice for diagnosis and treatment. Work on the morphometrical study of the sacral hiatus is limited, especially in south indian population. So this study is carried to examine, measure and record the morphometry of sacral hiatus in order to study the anatomical variations which will be useful for caudal epidural anaesthesia.

Material and Methods: The study was conducted in the Department of Anatomy, Prathima Institute of Medical Science, Naganur, Andhra Pradesh. 93 dry sacra with complete sacral hiatus were taken for the study.. The shape of the sacral hiatus was noted by naked eye. Level of the apex and base of the sacral hiatus was noted with respect to the sacral vertebra. The length of sacral hiatus was measured from apex to the midpoint of base, the anteroposterior depth of sacral hiatus at the apex was measured with the help of vernier calipers. The transverse width of sacral hiatus at the base was measured between the inner aspects of inferior limit of the sacral cornu with the help of divider and then adjusted, and calculated with vernier caliper.

Results: In 47 (50.53 %) sacra the shape was Inverted-U and in 25 (26.9 %) sacra Inverted-V. The irregular shaped of sacral hiatus was observed in 11 (11.8 %) cases. A "Dumbbell" shaped sacral hiatus was observed in 5 (5.4%) cases with a nodular bony growth projecting medially from both margins . The dorsal wall of sacral canal was entirely absence in 4 (4.3%) cases . Absence of sacral hiatus, a rare phenomenon, was observed in 1 (1%) specimens only.

Conclusion: In the present study, elongated hiatus and narrowing of the sacral canal at apex of sacral hiatus was found in a significant percentage, which should be kept in mind while giving the caudal anaesthesia in Andhra Pradesh region.

Key words: apex, base, caudal epidural anaesthesia, sacral hiatus.

INRODUCTION

The Sacrum is a large triangular bone formed by the fusion of five sacral vertebrae and forms the caudal end of the vertebral column. It forms posterosuperior wall of the pelvic cavity wedged between the two innominate bones. Its dorsal surface present an arch shaped gap at the caudal end called as the sacral hiatus [1].

Sacrum is one of the bones which exhibit variations [2]. The opening 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. The sacral hiatus transmits the fifth sacral nerve and coccygeal nerves [1]. The dural sac ends at the level of second sacral vertebra above the sacral hiatus. Therefore it forms a convenient region for caudal epidural anaesthesia of structures innervated by these nerves.

The sacral hiatus is the site for caudal epidural anesthesia during perineal surgery and also for a painless delivery. It is also used for three dimensional color visualization of lumbosacral epidural space in orthopaedic practice for diagnosis and treatment.

Work on the morphometrical study of the sacral hiatus is limited, especially in south indian population. The present study was undertaken to find out the anatomical variations of sacral hiatus of the cadaver of south Indian population in and around Karimnagar and is expected to help in filling this deficiency at least to a certain extent.

MATERIALS AND METHODS

This is a Cross-sectional study carried out on 93 dry human sacra in Andra pradesh to study the anatomical variations of sacral hiatus.

The study was conducted in the Department of Anatomy, Prathima Institute of Medical Science, Naganur, Karimnagar, Andhra Pradesh. 93 human sacra were collected from Department of Anatomy, Prathima Institute of Medical Science, Naganur, Karimnagar. Only dry sacra with complete sacral hiatus were taken for the study. Damaged sacra were excluded for the study. Various parameters were studied and measured. The shape of the sacral hiatus was noted by naked eye. Level of the apex and base of the sacral hiatus was noted with respect to the sacral vertebra. The length of sacral hiatus was measured from apex to the midpoint of base, the anteroposterior depth of sacral hiatus at the apex was measured with the help of vernier calipers. The transverse width of sacral hiatus at the base was measured between the inner aspects of inferior limit of the sacral cornu with the help of divider and then adjusted, and calculated with vernier caliper. The data were entered in SPSS version 15.0 and was used for the analysis and presentation of data.

RESULTS

All the sacrum studied were composed of five segments in 93 (100%) cases. There were many variations in the shape of sacral hiatus and is shown in table 1.

Table 1: Shape of sacral hiatus

SN	Shape	Number	%
1	Inverted- U	47	50.53
2	Inverted- V	25	26.9
3	Irregular	11	11.80
4	Dumbbell	5	5.4
5	Absence of dorsal wall	4	4.3
6	Absence of sacral hiatus	1	1.07
Total		93	100

In 47 (50.53 %) sacra the shape was Inverted-U and in 25 (26.9 %) sacra Inverted-V. Both the above types were considered as normal and the sacral hiatus was present against 4th and 5th sacral segments. The irregular shaped of sacral hiatus was observed in 11 (11.8 %) cases. A “Dumbbell” shaped sacral hiatus was observed in 5 (5.4%) cases with a nodular bony growth projecting medially from both margins. The dorsal wall of sacral canal was entirely absence in 4 (4.3%) cases. Absence of sacral hiatus, a rare phenomenon, was observed in 1 (1%) specimens only.

The level of the apex of SH and that of base was quite variable (table 2 and 3). The level of the apex of SH extended between middle of 3rd to middle of 5th sacral segments (table 2).

Table 2: Level of Apex of Sacral hiatus with respect to level of sacral vertebra

SN	Level of Apex	Number	%
1	5 th Sacral Vertebra	3	3.40
2	4 th Sacral Vertebra	49	55.70
3	3 rd Sacral Vertebra	36	40.90
Total		88	100

Table-03: Level of Base of Sacral hiatus with respect to level of sacral vertebra

SN	Level of Base	Number	Percentage %
1	5 th Sacral Vertebra	79	89.77
2	4 th Sacral Vertebra	3	3.42
3	1 st coccyx vertebra	6	6.81
Total		88	100%

The anteroposterior depth of sacral canal at the apex ranged between 2mm to 9mm (Table.No.6 & 9).

Table 4: Length of Sacral hiatus from apex to midpoint of base

SN	Length of sacral hiatus (mm)	Number (n= 88)	Percentage %
1	0-10	8	9.09
2	11-20	39	44.31
3	21-30	27	30.70
4	31-40	13	14.77
5	41-50	1	1.13

Table 5 : Transverse width of sacral hiatus at the base measured between the inner aspect of inferior limit of sacral cornua

SN	Transverse width (mm)	Number (n=88)	Percentage (%)
1	0-5	1	1.14
2	6-10	18	20.46
3	11-15	51	57.95
4	16-20	18	20.45

Table 6: Anteroposterior depth of sacral canal at the level of apex

SN	AP depth (mm)	Number (n=88)	Percentage %
1	0-3	21	23.86
2	4-6	56	63.63
3	7-9	11	12.51



Fig no. 1: Absence of dorsal wall of sacrum

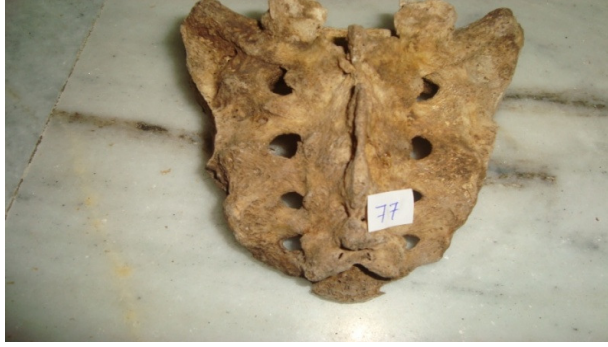


Fig no.2: Absence of sacral Hiatus

DISCUSSION

The detailed morphometric study of sacral hiatus is of great relevance, since this route is frequently utilized for caudal epidural anaesthesia in perineal surgery and caudal analgesia for a painless delivery. Edward and Hingson in 1941, for the first time took the advantage of this natural gap at the lower end of sacral canal for continuous caudal analgesia during labour [3]. Sacral hiatus has a somewhat triangular outline when seen from the dorsal aspect [4]. The level of the apex of sacral hiatus lies at the lower third of the body of 4th sacral vertebra and sacral hiatus is the place where caudal epidural anaesthesia is given for the operations on sacral dermatomes.

In the present study the shapes of sacral hiatus were mostly inverted-U shaped (51.6%) and inverted-V (25.8%). Both the above types were considered as normal. In 5 (5.4%), its outline was like a Dumb-bell which was very low when compared to previous workers. Nagar (2004)-reported dumb-bell shape in 13.3% [4] and Kumar et al (1992) reported such cases in 7.43% cases [5]. Bifid sacral hiatus was seen in 4 sacra (2%) in our study which was similar to that reported by other study [4]. It was in about 1.5% cases. There were several studies in which there is reported cases of complete agenesis of sacral

hiatus. Trotter et al reported agenesis in 1.8% [6], Vinod kumar et al [5] in 3 sacra (1.49%) and Nagar in 4 sacra (1.5%)[4]. Kiran. V. et al found 1 sacrum as agenesis of sacral hiatus due to absence of dorsal wall of sacral canal out of 50 sacra(2%)[7]. Suma H Y studied 150 sacra, out of that inverted -U(44%), inverted-V(28.27%), irregular (10.1%), dumbbell(12.3%) and complete spina bifida(5.33%). The apex of the sacral hiatus was found at the level of 4th sacral vertebra(77.5%) and base of the sacral hiatus was found at the level of S5(64.38%)[8]. In the present study complete agenesis was found in 4(5.4%) and absence of sacral hiatus due to bony over growth, a rare phenomenon was observed in single sacrum (1.07%) which was similar in other two study; in 2 (0.7%)sacra [4] and in 0.9% [5]. But in a study conducted by Sekiguchi et al , sacral hiatus was absent in 3% cases which was higher [9]. Nagar SK also noted various shapes of sacral hiatus most common being inverted-U in 112 (41.5%) sacra and inverted-V in 73sacra (27%) [5]. Vinod kumar et al also noted various shapes of sacral hiatus, most common being inverted-V in 94 (46.53%) and inverted-U in 60 (29.70%) [5].

Susan Strandring et al states that the apex of sacral hiatus is present at the level of 4th sacral vertebra [1]. In the present study the apex of sacral hiatus was seen most commonly at the level of 4th sacral vertebra in 49sacra (55.70%), which was almost similar [4], higher [5, 8]. Earlier studies by Trotter et al and Lanier et al in their series have reported the mean level of apex of sacral hiatus to be at lower third of 4th sacral vertebra [6, 10].

Most of the studies including the present study noted that location of apex can vary from upper part of second sacral vertebra to lower part of fifth sacral vertebra. Base of the

sacral hiatus was seen at the level of fifth sacral vertebra in 89.77% in the present study, which was higher when compared to study conducted by Kumar et al [5], (83.17%) and also when compared to Nagar SK [4]. 191 sacra (72.6%) at the level of fifth sacral vertebra out of 270 bones studied.

Length of sacral hiatus varied from 4mm to 42 mm and the arithmetic mean was 19.73mm and median was **19.00mm** and reference range was between 6.68 to 38.62mm in the present study. This is similar to that reported by earlier workers [5] who observed mean length of sacral hiatus as 20mm in males and 18.9mm in females among north Indians. Sacral hiatus length in American males and females was found to be 24.8mm and 19.8mm respectively [6]. Similar results were noted by Lanier et al noted mean length being 25.3mm [10].

Anteroposterior depth of sacral canal at apex of sacral hiatus is important as it should be sufficiently large to admit a needle. Various diameters lead to subcutaneous deposition of anaesthetic drug. In the present study the anteroposterior depth ranged from 2 to 9mm with arithmetic mean of 4.0mm and median of 4.0mm. This report is similar and comparable to the finding of other scholar [3, 5, 9, 10].

In the present study, sacra having anteroposterior depth of sacral canal at apex of sacral hiatus less than 3mm was observed in 21 (23.86%) cases which is higher than the earlier studies [6] Nagar SK noted in 4 sacra (15.6%) with 0 – 3mm depth, while Lanier et al (1944) noted no cases with depth less than 3mm [4, 10]. In present study anteroposterior depth of sacral canal at apex of sacral hiatus ranges between 4mm - 6mm in 56 bones (63.63%) which was similar to previous study in Indian population [4].

Arithmetic mean was 4.0mm in the present study, which was similar to the study conducted by Kumar et al as 4.8mm [5].

In the present study the transverse width varied from 4 to 18mm, having arithmetic mean of 12.11mm, **median 11.84mm** and reference range between 5.38mm to 17.45mm. In more than half 57.95% cases transverse width of sacral hiatus at base was from 11mm – 15mm and in 78.4% cases transverse width was from 6mm – 15mm which was almost similar to the next study conducted in india [4] which ranges from 3mm – 19mm and in more than half 54% cases it was 10mm – 15mm and in 84% cases it was from 6mm – 15mm. The transverse width was higher among Americans compared to present study. It varies from 7mm – 26mm with arithmetic mean of 17mm among Americans [6]. Lanier et al also reported bigger transverse width at base to be 19.3mm than to the present study [10]. Sekiguchi M et al have reported a lower arithmetic mean of transverse width to be 10.2mm among [9].

CONCLUSIONS

The percentage of absent of sacral hiatus due to fusion of sacral cornua is 1.07% and non formation of sacral hiatus due to absent dorsal wall of sacral canal is 5.40%. In both the above condition the epidural anesthesia will be failure (upto 7%). If there is a doubt about these to variation then MRI/Fluoroscopy should be done to visualize them, before taking of the procedure of the epidural anesthesia. There are anatomical variations in the sacral hiatus, which may relate to the complication to caudal epidural anesthesia. Understanding of these variations may improve the success rate of caudal epidural anesthesia in this part of population.

ACKNOWLEDGEMENT

Authors wish to acknowledge the support of Assoc. Prof. Kshitiz Upadhyay-Dhungel, department of Physiology, JMC, Janakpur for his support in preparation of manuscript.

REFERENCES

1. Standring S. Grays Anatomy, 39th Ed, Elsevier Churchill Livingstone, London, 2005; P: 749 – 754.
2. Esses SE, Botsford DJ: Surgical Anatomy and Operative Approaches to the Sacrum, In Frymoyer JW, Ducker TB, Hadler NM et al (eds): The Adult Spine. Principals and Practice, 2nd Ed. Philadelphia: Lippincott-Raven, 1997; 2:2329 – 2341.
3. Edwards WB, Hingson RA. Continuous caudal anaesthesia in obstetrics. American journal of surgery 1942; 57: 459 - 464.
4. Nagar SK. A study of sacral hiatus in dry human sacra. Journal of Anatomical Society of India 2004; 53(2): 18 - 21.
5. Kumar V et al. Morphometrical study of sacral hiatus. Journal of Anatomical society of India 1992; 41(1): 7 – 13.
6. Trotter M. and Letterman GS. Variations of the female sacrum: Their significance in continuous caudal anaesthesia. Surg. Gynecol. Obstet 1944; 78(4): 419 - 424.
7. Kiran V et al. Agenesis of dorsal wall of sacral canal. Anatomica karnatka 2011; 5 (1): 69-71.
8. Suma HY et al. A study of sacral hiatus among sacra in south Indian population. Anatomica karnatka 2011; 5 (3): 40-44.
9. Sekiguchi M, Yabuki S, Satoh K, Kikuchi S. An Anatomical Study of the Sacral Hiatus: A Basis for Successful Caudal Epidural Block. Clinical journal of Pain 2004; 20(1): 51 – 54.
10. Lanier VS, Mcknight HE, Trotter M. Caudal analgesia: An experimental and anatomical study. American journal of Obstetrics and Gynaecology 1944; 47(5): 633 – 641.