ORIGINAL ARTICLE

Morphometrical analysis of sacral hiatus and its clinical significance

Authors: Vijisha Phalgunan, Baskaran S

Corresponding author: Dr. Vijisha Phalgunan
Asst. Professor, Department of Anatomy
Mahatma Gandhi Medical College & Research Institute, Puducherry
Mail ID: drvijishabaski@gmail.com

ABSTRACT

Aim: To find some important landmarks to enhance the location of apex of sacral hiatus for successful caudal epidural block and also a detailed morphometric analysis of Sacral hiatus. **Material and methods:** Thirty dry sacral bones were used. Parameters pertaining to the sacral hiatus were determined and readings were taken. Measurements were made using Vernier calliper accurate to 0.1 mm. **Results:** The dorsal wall of the sacrum was deficient in two cases. The determined bony landmarks favoured the formation of an equilateral triangle. The apex of sacral hiatus was found to occur at 3rd in 46% and 4th in 46% level of sacrum, and the position was found to be varying between 2nd to 4th sacral levels. The mean antero-posterior diameter of sacral canal at the level of apex was found to be 5.9 (2.09) mm (range 4-10mm), in 16 (57%) sacrum it was between 4-6 mm. In 10 (35%) sacra the shapes were found to be Inverted–U and as Inverted–V respectively. In 8 (28%) sacra the shape was found to be Irregular. **Conclusion:** The given bony landmarks in combination with other technique would improve the success rate of caudal epidural block. The variabilities provided in this study should be kept in mind before giving caudal epidural Block.

Key words: *Caudal epidural block, sacral hiatus, supero-lateral crest*

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 sacral canal is formed by the vertebral foramina of sacral vertebrae, its upper opening is at the basal surface and lower opening is the sacral hiatus. The sacral canal contains the cauda equina including the filum terminale and the spinal meninges. Opposite the middle of the sacrum the subarachnoid and subdural spaces becomes closed. The filum teminale emerges below at the sacral hiatus and passes downwards. The fifth sacral spinal nerves also emerge through the sacral hiatus close to the medial side of the sacral cornua. [1] The sacral hiatus is covered only by skin, a subcutaneous fatty layer and the sacro-coccygeal membrane. [2] Sacral hiatus is located between the sacral cornua and inferior to the 4th sacral spinous process or median sacral crest. During a caudal epidural block, the anaesthetic solution spreads superiorly and extra-durally where it acts on sacral and coccyx spinal nerves of the cauda equina. [3]

AIMS AND OBJECTIVES

The aim of the study is to conduct a detailed morphometric analysis of sacral hiatus and to find some important landmarks to enhance the location of apex of sacral hiatus for successful caudal epidural block.

METHODOLOGY

Study samples consist of thirty adult sacrum of unknown sex obtained from Mahatma Gandhi Medical College and Research Institute, Puducherry. Various parameters were taken; bones showing wear and tear, fracture or pathology were excluded. All the measurements were taken using Vernier callipers. Linear recording was taken to the nearest millimetre and statistical analyses were carried out.

The following landmarks were selected. (Figure 1)

i. Distance between the right supero-lateral crest to the apex of sacral hiatus
ii. Distance between the left supero-lateral crest to the apex of sacral hiatus
iii. Distance from the apex of sacral hiatus to S2
iv. Distance from the base of sacral hiatus to S2
v. Antero-posterior diameter of apex of sacral hiatus
vi. Location of sacral hiatus
vii. Distance between sacral cornua
viii. Shape of sacral canal

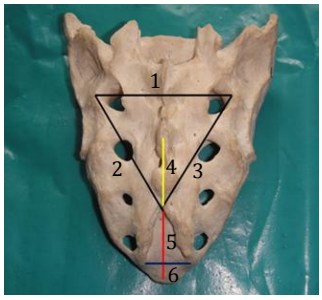

Figure 1: Measured parameters
1. Distance between two supero-lateral crests (base of triangle),
2. Distance between right supero-lateral crest and apex of sacral hiatus,
3. Distance between left supero-lateral crest and the apex of sacral hiatus,
4. Distance between S2 to apex of sacral hiatus,
5. Length of sacral hiatus,
6. Distance between sacral cornua,
7. Distance between S2 to base of sacral hiatus (4+5)

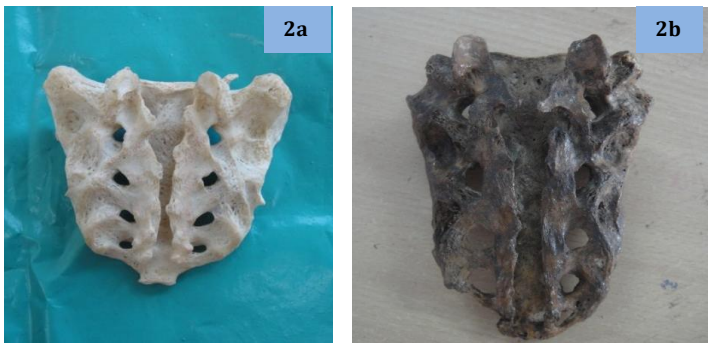

Figure 2a, 2b: Sacrum: Dorsal wall deficient

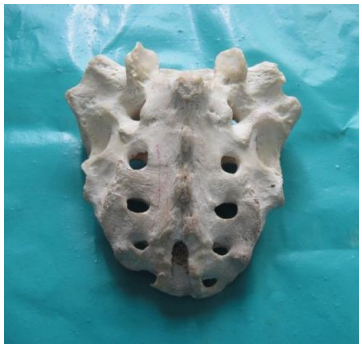

Figure 3: Sacral Hiatus: Inverted–U shape

Figure 4: Sacral Hiatus: Inverted-V shape

Figure 5: Sacral Hiatus: Irregular shape

RESULTS

The dorsal wall of the sacrum was deficient in two cases (Figure 2a, 2b). Hence, these two samples were not considered for the measurement. The results of the measurements are tabulated (Table 1). The average length of the sacral hiatus was 21.13 (12.74) mm (range 10-59 mm). The length was mostly between 10 and 20 mm (Table 2). The average distance between the right and left supero-lateral crest forming the base of the triangle was 55.46 (16.51) mm range (46-75 mm). The distance between right supero-lateral crest and apex of sacral hiatus was 50.83 (19.57) mm range (40-77 mm). The distance between the left supero-lateral crest and the sacral Apex was 49.76 (19.55) mm range (41-78 mm). It is important to know that the distances from right and left sacral crests to the hiatus were almost similar in each sacrum. The level of the apex of sacral hiatus extended between 2nd to 4th sacral segments. They were quite variable in positions. In 13 cases (46.4%) the apex was present at the level of 3rd and4t h sacral segment in each respectively. In 2 cases (7.14%) the apex was found to be present against 2nd sacral segment (Table 3).

The width of the sacral hiatus at the level of sacral cornua was 17.56 (2.94) mm (range 13-25 mm), and it was found that 26 (92%) sacra the distance was within the range 11-20 mm (Table 4).

There were also variations in the shape of sacral hiatus which were classified as Inverted-U, Inverted–V and irregular (Figure 3,4,5) and its occurrence are tabulated in Table 5. In 10 (35%) sacra the shapes were as Inverted–U and as Inverted–V respectively. In 8 (28%) sacra the shape was found to be Irregular.

The mean antero-posterior diameter of sacral canal at the level of apex was found to be 5.9 (2.09) mm (range 4-10 mm), in 16 (57%) sacrum it was between 4-6 mm and only in 1 case (3.5%) it was above 9 mm (Table 6) .

The distance of 2nd level of sacrum to the apex of the sacral canal was 31.1 (16.03) mm on average range (3- 51 mm) and the distance to the base of the sacral hiatus was 60.23 (17.97) mm range (50-80 mm).

Table 1: Results of measured parameters

Parameters	Mean (mm)	Std. Dev (mm)	Median (mm)	Max (mm)	Min (mm)
Length of sacral hiatus	21.13	12.74	18	59	10
Distance between the sacral cornua	17.56	2.94	17	25	13
Diameter at the apex of sacral canal	5.9	2.09	6	10	4
Distance between the supero-lateral crests	55.46	16.51	58	75	46
Distance between the right postero-lateral crest and apex of sacral hiatus	50.83	19.57	55	77	40
Distance between the right postero-lateral crest and apex of sacral hiatus	49.76	19.55	55.5	78	30
Distance between S2 to apex of sacral hiatus	31.1	16.03	36.5	51	3
Distance between S2 to base of sacral hiatus	60.23	17.97	63.5	80	50

Table 2: Length of sacral hiatus

	10-20 mm	21-30 mm	31-40 mm	41-50 mm	>50 mm
Number (%) of specimens	17 (60%)	7 (25%)	1 (3.5%)	-	3 (10%)

Table 3: Location of Apex of Sacral Hiatus

	S2 level	S3 level	S4 level	Open/deficient wall
Number (%) of specimens	2 (7.1%)	13 (46%)	13(46%)	2 (7.1%)

DISCUSSION

Caudal epidural block has 25% failure rate. [4] Mostly due to the anatomical variations at the level of apex of sacral hiatus, difficulty in palpating in some patients and also includes dorsal wall deficient cases. Some easy anatomical landmarks are followed to guide the clinicians for a successful caudal epidural block. In the present study, the formation of equilateral triangle between the two sides of supero-lateral crest and the apex of the sacral hiatus was taken as the bony landmark and an equilateral triangle was found to be occurring in four sacra (14.2%). With the same landmark the formation of equilateral triangle was reported to be 29%. [5] In another study, instead of supero-lateral crest as a landmark, equilateral triangle was observed between the posterior superior iliac spine and sacral hiatus it was reported to occur in 51% specimens. [6]

The diameter of the sacral canal is important to decide on the accurate needle usage for the epidural block. It has been reported that the diameter was 2 mm in 55 cases. [7] In another series of study it was 2 mm or less in only 6.25% sacrum. [8] Whereas it was reported to be only 1% sacral bones in another study. [2] In the present study, the diameter of sacral canal predominantly was between 4-10 mm in 57% which was comparable with the other reports which was reported as 38.67% and 64.2% [9,10] and there were no occurrence with less than 4 mm.

Hiatal agenesis was observed in 4% sacrum by Sekiguchi and Colleagues [2], and it was found to be 12.5%[8] in another study. In our study dorsal wall was deficient in 2 cases (6.6%).

It was observed that the distance between the sacral cornua 17.56 (2.94) (13-25) mm is greater than the depth of sacral hiatus 5.9 (2.09) (0-10 mm) which was almost similar to the values of Senoglu [8] as 17.47 (3.23) (7-28) and 4.46 (1.33) (1-7 mm).

The risk of dural puncture must be always taken care of as the dural sac covering the spinal cord will extend upto the sacrum upto second sacral vertebra. Hence during introduction of the needle the knowledge of average distance of needle penetration is necessary. The distance between the level of second sacral vertebra and the apex of sacral hiatus was found to be 31.1 (16.03) range (3-15 mm) and the distance between the base of sacral hiatus was 60.23 (17.97 mm) range (50-80 mm) which was slightly smaller than those measured by Senoglu [8] which was 35.4 (10.4 mm) range (11-62 mm), 65.3 (9.4 mm) range (39-85 mm). Hence from these data it would be safer to advance the needle only few millimetres after penetrating the sacro-coccygeal membrane.

Table 4: Distance between the levels of Cornu

Sl. No.	Length (mm)	No. of specimens	Percentage
1	0-10	-	-
2	11-20	26	92%
3	>20	4	14%

Table 5: Shapes of Sacral Hiatus

Shapes	No. of specimens	Percentage
Inverted –U	10	(35%)
Inverted – V	10	(35%)
Irregular	08	(28%)

In present study, the shapes of sacral hiatus were classified as Inverted–U, Inverted-V and as irregular, the shapes were variable and were found to be predominantly of either inverted–U or inverted–V shapes which occurred in 35% sacral hiatus respectively. In another study the shapes of sacral hiatus were reported as Inverted-U in 41.5% and Inverted–V in 27% sacra. [10] Vinod kumar [11] also noted various shapes, most common being Inverted-V in 46.53% and Inverted–U in 29.70%. In present study 28% sacra showed irregular shape which was reported to be 15.5% sacra, 14.1% sacra in other studies. [9,10]

Table 6: Antero-posterior diameter of apex of sacral hiatus

Sl. No	Length (mm)	No. of specimens	Percentage
1	0-3	-	
2	4-6	16	57%
3	7-9	11	39%
4	>9	01	3.5%

The apex of sacral hiatus was reported at the level of 4th sacral vertebra. [12] The position at this level was reported by many authors 76.23%, 59.33%, 55.9%. [9,10,11] In present study almost 46.4% sacra the apex was found between 4th and 3rd sacral segment respectively and in 2 cases (7.14%) it was found to be at the level of 2nd sacral segment. Hence it was observed in all studies including present study that the location of Apex of Sacral hiatus is variable between the 2nd to 4th sacral vertebra.

Length of sacral hiatus vary from (10-59) mm and the arithmetic mean 21.13 mm and the median was 18 mm. This was similar to arithmetic mean length of sacral hiatus as 20 mm in males and 18.9 mm in females in North Indian population range between (3-37 mm) reported by Vinod Kumar et al [11]. Similar results were noted by Trotter [13] the mean length as 22.5 mm range (0-60 mm) and Lanier et al mean length as 25.3 mm [14] .

CONCLUSION

Present study concludes in support of other studies regarding variability in the anatomical structure of sacral hiatus. The incidence of Variations may be due to genus and racial factors. Exact location of sacral hiatus in caudal epidural block determines its success rate; the given landmarks resulting in the formation of equilateral triangle to an extent provide practical benefit to the clinicians. The variabilities provided in this study should be kept in mind before giving Caudal Epidural Block.

REFERENCES

1. Gray's Anatomy, 35th edition, Orient Longman 1973; pp : 242-244.
2. Sekiguchi M, Yabuki S, Satoh K, Kikuchi S. An anatomic study of the sacral hiatus: a basis for successful caudal epidural block. Clin j pain 2004;20:51-4.
3. Moore KL, Dalley AF. Clinically Oriented Anatomy 5th edition, Lippincott Williams & Wilkins 2006; pp-493.
4. Tsui BC, Tarkkila P, Gupta S, Kearney R. Confirmation of caudal needle placement using nerve stimulation. Anaesth Analg 1999;91:374-8.
5. Patil D, Jadav H, Kumar B, Mehta CD, Patel VD. Anatomical study of sacral hiatus for caudal epidural block. Nat J Med Res 2012; l2(3): 272-275.
6. Aggarwal A, Kaur H, Yatindra K, Babia, Aditya K, Subramanyam R, Daisy Sahni. Anatomical consideration of caudal epidural space: a cadaver study. Clinical Anatomy 2009; 22(6): 730-737.
7. Waldman SD. Caudal epidural nerve block: prone position. In: Atlas of interventional pain management, 2nd edition. Philadelphia: Saunders, 2004; 380-92.
8. Senoglu N, Oksiz H, Gumusalam Y, Yuksel KZ, Zencirci B, Ezberci M and Kizilkanat E. Landmarks of the sacral hiatus for caudal epidural block: an anatomical study. Brit J Anaesth 2005; 95(5): 692-5.
9. Patel ZK, Thummar B, Rathod SP, Singel TC, Patel S, Zalawadia A. Multi-centric morphometric study of dry human sacrum of Indian population in Gujarat region NJIRM 2011; 2(2):31-35.
10. Nagar SK. A study on sacral hiatus in dry human sacra JASI 2004; 53(2):18-21.
11. Kumar V, Pandey SN, Bajpai RN, Jain PN, Longia GS. Morphometric study of sacral hiatus. JASI 1992; 41(1):7-13.
12. Strandring Susan. Grays Anatomy, 39th ed, Elsevier Churchill Livingstone, London, 2005; P: 731.
13. Trotter M. Varitaions of sacral canal: their significance in administration of caudal analgesia. Anaesth Analg 1947; 26(5):192-202
14. Lanier VS, Mcknight HE, Trotter M. Caudal analgesia: An experimental and anatomical study. Am J Obstet Gynaec 1944; 7(5):633-641.

Particulars of Contributors:

1. Dr. Vijisha Phalgunan, Asst. Professor
   Dept. of Anatomy
   Mahatma Gandhi Medical College and Research Institute
   Pondicherry
2. Dr. Baskaran S, Specialist in Cardiac Care Unit
   Dr. Sulaiman Al Habib Medical group
   Riyadh, Saudi Arabia

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