Archives of Anesthesiology and Critical Care (Sumer 2022); 8(3): 178-182.

Available online at http://aacc.tums.ac.ir

Research Article

Morphometric Analysis Sacral Hiatus of Dry Bone in Iranian Population

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ARTICLE INFO

Article history:
Received 23 January 2022
Revised 15 February 2022
Accepted 30 February 2022

Keywords:
Caudal epidural block;
Morphometry;
Sacrum;
Sacral hiatus;
Sacral cornua

ABSTRACT

Background: Caudal epidural block (CEB) has been widely used to treat lumbar spine disorders, to manage chronic low back pain, and to provide analgesia and anesthesia in operations such as labor pain and orthopedic and genital surgeries. The CEB technique depends on the precise location of the sacral hiatus (SH) through which access to the sacral epidural space is obtained. For optimal access to the sacral epidural space, accurate knowledge of the SH descriptive profile is required.
Methods: The study was performed on 23 sacrum bones. All bones were of Iranian (Persian) origin. Bones that were worn, corroded, broken, or had any anatomical problems were excluded. The parameters were measured: Sacral hiatus Length, distance between base of hiatuse-S2, liner distances between apex of sacral hiatus till right and left ends of lateral sacral crest were measured. Distance between Apex of sacral hiatus till S2, Antherio-posterior diameter of SH and location of sacral hiatus and types of SH.
Results: This study showed that the highest type of sacral hiatus in Iranians with a frequency of 38% is inverted V shape and the lowest type of deficiency shape is with a frequency of 4.8%.
The position of sacral hiatus in the Iranian sacrum showed that the highest position was with a frequency of 45% in front of the sacral vertebra 4 and the lowest case in front of the third sacral with a frequency of 15%. The height of sacral hiatus was the highest case with a height of 21-30 mm (50% or cases 9). Anterior-posterior diameter of sacral hiatus was 4-6 mm in The most common case 75% or cases 15.
It was shown that the mean distances between S2 till apex of the sacral hiatus 56.65 mm and the mean distance between S2 till base of the sacral hiatus is 36.85 mm.
Conclusion: Successful application CEB enables comfortable anesthesia for patients and helps them to resume an active life soon. Accurate understanding of the SH location is important to reduce the risk of intraoperative as well as damage to vital structures. The present study aimed to determine positional changes and measure SH distances. Also, the aim of this study was to determine SH landmark points, perform accurate and standard morphometric measurements and calculate safe SH areas in CEB application.

Caudal epidural block (CEB) has been widely used to treat lumbar spine disorders, to manage chronic low back pain, and to provide analgesia and anesthesia in operations such as labor pain and orthopedic and genital surgeries [1]. The CEB technique depends on the precise location of the sacral hiatus (SH) through which access to the sacral epidural space is obtained [2]. For optimal access to the sacral epidural space, accurate knowledge of the SH descriptive profile is required.

The authors declare no conflicts of interest.
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Absence of fusion of the laminae of the fifth and occasionally fourth sacral vertebra leads to the formation of sacral hiatus (SH) [1]. It can be palpated about 2 inches above the tip of the coccyx lying beneath the skin of natal cleft, that It contains lower sacral and the coccygeal nerve roots, filum terminalis and fibro- fatty tissue [2]. SH is covered by skin, subcutaneous fat layer and sacro-coccygeal membrane. These structures must be perforated to reach the sacral canal [3]. The lateral margins of the sacral hiatus are formed by the downward extensions of the inferior articular processes of the fifth sacral vertebra and its remnants which are called the sacral cornua, form an important landmark during CEB [4]. The opening that is present at the caudal end of the sacral canal is known as sacral hiatus. The lower sacral nerve roots, coccygeal nerve roots, filum terminale crossed of this sacral hiatus. This hiatus is covered by superficial posterior coccygeal ligament which is attached to the margins of the hiatus and the deep posterior sacro-coccygeal ligament attached to the floor of the sacral hiatus. This sacral hiatus has been utilized for administration of Epidural anesthesia in orthopedics for diagnosis and treatment of various diseases as well as in Obstetrics [7]. The success, reliability, and reliability of caudal epidural anesthesia depend on the structural and anatomical changes of the sacral hiatus [8].

It is a proven fact that morphological traits are affected by racial variation [2]. In addition, there is little information about the anatomical types and morphometric details of SH in Iranians. The aim of this study was to investigate the anatomical features and morphometric parameters of SH in Iranian human dry sacra in order to facilitate correct and uncomplicated epidural access required for CEB.

Methods

The study was performed on 23 sacrum bones. These bones were available in the modeling hall of Arak University of Medical Sciences. All bones were of Iranian (Persian) origin. Bones that were worn, corroded, broken, or had any anatomical problems were excluded. The parameters were measured as follows.

1- Sacral hiatus Length: distance between apex till base of sacrum.

2- Distance between base of hiatus -S2 (Figure 1- F-G line)

3- linear distances between the apex of SH and the upper right and left ends of the lateral sacral crest (lateral upper sacral crest) were measured (Figure 1 C-Dline).

4- Distance between Apex sacral hiatus-S2: Direct distance between the apex of the sacral hiatus and the foramen of the second sacral vertebra Measured (Figure 1).

5-Anterior- posterior diameter of sacral hiatus. All these parameters were measured using the digital caliper with an accuracy of 0.1 mm

6-Shape of sacral hiatus

7-The Location of sacral hiatus

Figure 1- sacrum, dorsal view

line A-B distance between Right and left S2. Line C-D distance between upper right and left ends of the lateral sacral crest (lateral upper sacral crest), lines C-F and D-f distances distance between upper right and left lateral sacral crest till sacral apex., line F-G sacral hiatus length, F sacral apex G=base of sacral hiatus

Results

Of the 23 healthy sacrum in the museum bone salon, 15 (65%) were male and the rest were female.

As (Table 1) shows, 45.5% (10 cases) of the sacrum were over 50 years old.

(Table 2) shows the measures of all sacral parameters, which show the minimum, maximum, mode and mean± standard deviation of the mean in the parameters.

(Table 3) shows the frequency of different shape of sacral hiatus, the highest frequency of which is the V invert shape and is only one deficiency shape case.

The location of the sacral hiatus can be seen in (Table 4), the highest with a frequency of 45% that is parallel to the S4.

The height of sacral hiatus is shown in (Table 5), the highest case with 50% (case 9) with a height of 21-30 mm.

Anterior-posterior diameter of sacral hiatus is shown in (Table 5). The most common case is 75% (case 15) with 4-6 mm diameter.

Table 1- Minimum and maximum and median, mean and standard deviation, mode in the parameters of the sacrum

parameter	NO	Minimun(mm)	Maximum(mm)	Mean±SD
Sacral hiatus Length	23	10.00	38.00	22.05±7.29
Distance between base of hiatus &S2	23	25.0	51.00	36.85±7.79
Distance between Apex sacral hiatus&S2	23	26.00	70.00	56.65±12.51
Distance between right supero-lateral crest and Apex sacral hiatus	23	45.00	85.00	65.64±10.17
Distance between left supero -lateral crest and Apex sacral hiatus	23	43.00	83.00	65.55±10.54
Distance between left and right supero -lateral crest	23	58.0	82	70.05±5.96

Table 2- shows the frequency of different shapes of sacral Hiatus

Type of hiatus	No	percent
Invert U shape	6	28.6
Invert V shape	8	38.1
Irregular	6	28.6
deficiency	1	4.8

Table 3- shows the Location of sacral hiatus

Position of hiatus	No	percent
S3	3	15
S4	9	45
S5	8	40

Table 4- shows the height of the hiatus sacral

Length of hiatus-(mm)	NO	percent
10-20	7	38.9
21-30	9	50.0
31-38	2	11.1

Table 5- shows the anterior-posterior diameter of the sacral hiatus

Ant.post diameter of hiatus(mm)	NO	precent
0-3	1	5.0
4-6	15	75.0
7-9	3	15.0
+9	1	5.0

Discussion

The present study was performed to investigate the anatomical changes of sacral Hiatus (SH) in the Iranian population living in central Iran. Hence this is the first study on the Persian race. Identifying the caudal epidural space is not always easy, even for experienced physicians. The study of changes related to the anatomical features of sacral hiatus is very important due to its clinical applications in caudal epidural anesthesia. Anatomical changes can be effective. The landmark point in bone success in CEB is the sacral hiatus, which can be difficult to touch, especially in obese people. In patients, anatomical or technical complications include direct needle damage to the spinal cord and spinal nerve, severe subdural, accidental dural rupture, epidural hematoma, epidural abscess, anterior spinal cord syndrome and ischemia [6, 9].

Therefore, other prominent anatomical landmark can be used, such as the triangle between the linear distance between the apex of the sacrum to the superolateral sacral crests in right and left sides and distance right to left the superolateral sacral crests (The base of the triangle-figure 1) [5].

We used this turning point to determine the sacral hiatus and based on this we obtained the following results in the dry bones of the Iranian population. In this study, an equilateral triangle was found, the two sides of which were approximately equal in linear distance between apex of the sacral hiatus and superolateral sacral crests in right and left (A, B lines in the figure1). 65.64 ±10.17 and 65.55± 10.54mm respectively. The linear distance between the right and left superolateral sacral crests (triangle base) is 70.05 ±5.96 mm.

In the present study, we also examined the types of sacral hiatus in the sacrum of Iran. Our study showed that the highest type of sacral hiatus shape with a frequency of 38%, inverted V-shape and the lowest type is deficiency shape with a frequency of 4.8%. (Table 2).

In this study, the position of sacral hiatus in the sacrum of Iranian population showed that the highest position with a frequency of 45% was against the sacral vertebrae 4 and the lowest position was against the third sacral with a frequency of 15% (Table3).

The height of the sacral hiatus is shown in (Table 4). Highest case with 50% (9cases) with a height of 21-30 mm.

The posterior anterior diameter of the sacral hiatus is shown in (Table 5). The most common case is 75% (15 cases) with a diameter of 4-6 mm.

In this study, it was shown that the mean distance between S2 till apex of the sacral hiatus is 56.65 mm and the mean distance between S2 till base of the sacral hiatus is 36.85 mm.

Manoj Bhavanidatta Joshi in Indian population study reported That all the sacrums studied were composed of five segments in 80 cases. There were many variations in the shape of sacral hiatus. In 38 (47.5%) sacra the shape was Inverted-U whereas sacra Inverted V was seen in 21(26.3%). Both the over sorts were considered as ordinary and the sacral break was show against 4th and 5th sacral sections [10]. The irregular shaped of sacral hiatus was observed in 12(15%) cases. A “Dumbbell” shaped sacral hiatus was observed in 5(6.3%) cases with a nodular bony growth projecting medially from both margins. The dorsal wall of sacral canal was entirely absence in 3(3.8%) cases. a rare phenomenon, absence of sacral hiatus was observed in 1(1.3%) only [15].

NADEEM, G in his study Different shapes of sacral hiatus observed which

included- Inverted U (56%), Inverted V (14%), Irregular (16%), Dumb-bell (10%), Bifid (2%) and Elongated (2%). The apex of the sacral hiatus was most commonly found at the level of 3rd sacral vertebrae in 62%. The

mean length of sacral hiatus was 25.2mm, the mean anteroposterior diameter of sacral canal at the apex of sacral hiatus was 5.53mm [13]. The results for shape and position of hiatus and anterio-posterior diameters were in Arab population differents with our results.

Amol A. Shinde reported in indian population inverted “U” shape (46.33%) was most commonly encountered. Apex and base of the hiatus were most commonly seen at the level of S4 and S5 respectively. Length of sacral hiatus ranged between 8.8 - 45.7 mm. AP diameter at apex of sacral and intercornual distance were most commonly in the range 4–6 mm and 11–15 mm respectively [14]. Their results are different from ours results.

Santanu Bhattacharya repoted: The average height and depth of the sacral hiatus were 3.592(mean)±0.3769(SD)cm and 0.723 (mean)±0.07cm respectively. The distance between right and left posterior superior iliac spines (superolateral sacral crests) was 6.48(mean)±0.5232(SD)cm and the distances from the apex of the sacral hiatus & sacral apex to those points were 5.841(mean)±0.2705(SD)cm,5.837(mean)±0.2769(SD)cm,8.137(mean)±0.2806(SD)cm,8.141(mean)±0.2793(SD)cm respectively [16].

These anatomical differences suggest that this may be due to genetic or nutritional in different racial populations.

Technique of the CEB depends upon accurate localization of sacral hiatus (SH) through which access to the sacral epidural space is gain ed [4, 8]. Dural sac ends against S2 vertebra [3-14]. The distance between the tip of the SH and the edge of the dural sac is about 4.5 cm and is essential in terms of dural function.

For a successful CEB intervention, clinicians are expected to know the anatomy of the sacral bone and the SH. Unfortunately, there are considerable anatomical variations in this area, and these result in discrepancies in the size and shape of SH which may make its identification difficult [1, 4, 13].

In some of the cases, insertion of the needle into the sacral canal may be impossible [7,9]. Locating hiatus remains a constant challenge for the clinicians. Surrounding bony landmarks are usually taken into consideration for this purpose. Confirmation of bony landmarks is the key to the success of the CEB [7-8].

Successful application will enable comfortable anesthesia for the patients and help them continue their active lives shortly. Detailed understanding of the location at the SH is important in order to reduce the intraoperative risk as well as the vital structures injury. The present study aims at determining the positional variations and measuring the distances of SH. The aim of this study was to determine the SH landmark points, conduct detailed and standardized morphometric measurements and calculate the safe areas of the SH in the application of the CEB.

Conclusion

Successful application CEB enables comfortable anesthesia for patients and helps them to resume an active life soon. Accurate understanding of the SH location is important to reduce the risk of intraoperative as well as damage to vital structures. The present study aimed to determine positional changes and measure SH distances. Also, the aim of this study was to determine SH landmark points, perform accurate and standard morphometric measurements and calculate safe SH areas in CEB application.

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