International Journal of Medical Research & Health Sciences

www.ijmrhs.com Volume 3 Issue 1 (Jan- Mar) Coden: IJMRHS Copyright @2013 ISSN: 2319-5886

Received: 24th Nov 2013 Revised: 15th Dec 2013 Accepted: 18th Dec 2013

Research article

MORPHOMETRIC STUDY OF THE SACRAL HIATUS IN NIGERIAN DRY HUMAN SACRAL BONES

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ABSTRACT

Background: The sacrum is a large triangular bone formed by the fusion of the five sacral vertebrae and forms the caudal region of the vertebral column. **Aims**: This was aimed at studying the morphometry of the sacral hiatus noting its anatomical variations that is useful in caudal epidural anaesthesia. **Materials and Methods**: Eighty three intact adult sacra of unknown sex were measured with vernier callipers and the various shapes of the sacral hiatus were also noted. **Results**: The findings revealed that inverted U (48.2%) was the most predominant shape; followed by inverted V (34.9%), dumbbell (4.8%), bifid (4.8%) and irregular (4.8%). The mean anteroposterior diameter at the apex was 5.52 ± 1.89mm. The mean length of the sacral hiatus was 20.05 ± 9.22mm and the transverse width at base of hiatus was 12.35 ± 3.12mm. There was complete spina bifida in 1.2% and absence of sacral hiatus in another 1.2%. **Conclusion**: The knowledge of anatomical variations of sacral hiatus is important in the administration of caudal epidural anaesthesia in the studied population and may help to reduce its failure rate.

Keywords: Sacral hiatus, caudal epidural block (CEB), sacral vertebra.

INTRODUCTION

The sacrum is a large triangular bone formed by the fusion of five sacral vertebrae and it also forms the caudal region of the vertebral column. It forms the posterosuperior wall of the pelvic cavity, wedged between the innominate bones.[1] Due to its great size, the sacrum is usually the last bone of a buried body to rot. The ancients may thus have believed the sacrum to be the focal point, around which the body could be reassembled in the after-life.[1] The opening at the caudal end of the sacral canal is the sacral hiatus formed due to failure of fusion of laminae of the fifth (occasionally 4th) sacral vertebrae.

The sacral hiatus is an inverted V-shaped space located at the distal part of the sacrum. This space is formed by incomplete midline fusion of the posterior elements of the distal portion of the fifth or sometimes, the fourth sacral vertebra. The sacral hiatus is covered posteriorly by the posterior aspect of the sacrococcygeal membrane and is an important landmark in caudal epidural block.[2]

Sacral approach to epidural space is used for giving analgesics and anaesthesia for a variety of operations. Caudal epidural block (CEB) has been widely used for the treatment of lumbar spinal disorders, management of chronic back pain, in obstetrics,[3] and orthopaedic practice.[4] The technique of CEB depends upon accurate localization of sacral hiatus through which access to sacral epidural space is gained. Some authors

have reported that one of the anatomic reasons of caudal epidural anaesthesia failure is the absence of sacral hiatus. One of the important key factors for successful caudal epidural anaesthesia may be clear understanding of the normal anatomy of sacral hiatus and surrounding structures.[4]

Sacral hiatus exhibits variations in morphology which differ among populations and the reliability and success of epidural anaesthesia depend upon these anatomical variations. These variations have not been well documented in the Nigerian population, hence this study is meant to address this.

MATERIALS AND METHODS

The study was conducted on 83 intact adult dry human sacra obtained from various Anatomy museums in the South-East and South-South zones of Nigeria. Bones of undetermined age and gender were used. They were preserved in dry conditions free from moisture, dust, insects or moths. Direct measurements were taken with vernier callipers (God Marc Tools, Japan; accurate to 0.02mm).

The parameters studied were the following:

i. Shapes of the sacral hiatus.
ii. Level of apex with respect to the sacral vertebrae.
iii. Level of base with respect to the sacral vertebrae.
iv. The length of the sacral hiatus measured from the apex to the midpoint of the base.
v. The anteroposterior diameter – at the apex.
vi. The transverse width at the base measured between the inner aspects of the inferior limits of sacral cornua.

Only sacra with complete sacral hiatus were used for the study and damaged, mutilated and deformed sacra were excluded.

Data Analysis: Data were expressed as mean and standard deviation for continuous variables, and percentage for categorical variables. Comparative analysis was done using Analysis of variance (ANOVA). The statistical software used was SPSS Version 16.0.

RESULTS

Table 1: Frequency distribution of the shape of sacral hiatus

Shape of Sacral Hiatus	Frequency	Percentage
Absent	1	1.2
Bifid	4	4.8
Complete spina bifida	1	1.2
Dumbbell	4	4.8
Inverted U	40	48.2
Inverted V	29	34.9
Irregular	4	4.8
Total	**83**	**100**

Table 2: Frequency distribution of the level of apex with respect to the sacral vertebrae.

Level of apex with respect to the sacral vertebrae	Frequency	Percentage
None	2	2.4
S2	2	2.4
S3	17	20.5
S4	58	69.9
S5	4	4.8
Total	**83**	**100**

Table 3: Frequency distribution of the level of base with respect to the sacral vertebrae

Level of base with respect to the sacral vertebrae	Frequency	Percentage
None	2	2.4
Coccyx	6	7.2
S4	2	2.4
S5	73	88

Total	83	100

Table 4: The length, transverse width and anteroposterior diameter of the sacral hiatus

Variables	Mean±SD	Median	Range
Length (mm)	20.05 ± 9.22	20.50	6.10 – 57.0
Transverse Width (mm)	12.35 ± 3.12	13.00	5.0 – 20.50
Anteroposterior Diameter (mm)	5.52 ± 1.89	5.10	0.40 – 11.10

Table 5: Mean and standard deviation of the length, transverse width and anteroposterior diameter according to the shape of sacral hiatus

Shape of Sacral Hiatus	Length (mm)	Transverse Width (mm)	Anteroposterior Diameter (mm)
Bifid	11.03 ± 2.48	11.03 ± 2.48	4.60 ± 1.73
Dumbbell	13.50 ± 1.08	13.50 ± 1.08	4.78 ± 0.52
Inverted U	22.17 ± 8.42	12.45 ± 2.80	5.26 ± 1.83
Inverted V	20.91 ± 9.88	12.81 ± 3.52	6.07 ± 2.06
Irregular	8.20 ± 2.51	8.20 ± 2.51	5.80 ± 1.70

Data are expressed as means and standard deviations.

Table 6: Mean and standard deviation of the length, transverse width and anteroposterior diameter of sacral hiatus according to the level of apex with respect to the sacral vertebrae

Level of apex with respect to sacral vertebrae	Length (mm)	Transverse Width (mm)	Anteroposterior Diameter (mm)
S2	49.55 ± 10.54	14.05 ± 1.34	8.60 ± 3.54
S3	26.59 ± 8.27	12.35 ± 2.55	5.43 ± 1.85
S4	17.81 ± 6.52	11.99 ± 3.05	5.42 ± 1.82
S5	10.0 ± 1.15	16.78 ± 4.25	5.78 ± 1.71

Data are expressed as means and standard deviations.

Table 7: Mean and standard deviation of the length, transverse width and anteroposterior diameter of the sacral hiatus according to the level of base with respect to the sacral vertebrae

Level of base with respect to sacral vertebrae	Length (mm)	Transverse Width (mm)	Anteroposterior Diameter (mm)
S4	28.0 ± 4.24	15.0 ± 2.83	6.50 ± 2.12
S5	19.48 ± 9.24	12.18 ± 3.14	5.44 ± 1.90
Coccyx	24.35 ± 8.64	13.57 ± 2.80	6.18 ± 1.82

Data are expressed as means and standard deviations.

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 painless delivery. Edward and Hingson in 1942 for the first time took advantage of this natural gap in the lower end of the sacral canal for continuous caudal analgesia during labour.[3] Since then, the sacral hiatus has been an important landmark in caudal epidural block. However, failures have often been encountered in caudal epidural block owing to anatomical variations in the sacral hiatus. In 1999, Tsui et al reported that the failure rate was about 25%.[5]

Shape

Table 1 showed the frequencies of the various shapes of sacral hiatus in the study population. The inverted U shape (48.2%) was most dominant, followed by the inverted V shape (34.90%), both of which were considered normal. The results were similar to studies by Seema et al[6] and Shewale et al.[7] In a study by Vijisha and Baskaran,[8] the inverted U and inverted V had equal frequencies of 35% each. The abnormal shapes constituted 15.6% and 1.2% were absent. Comparison with studies by other authors (

Table 8) showed similarities in the normal shapes, but the present study had lower frequencies in the abnormal shapes. Only the population under study presented with a bifid sacral hiatus.

Level of Apex

The level of apex of sacral hiatus in relation to sacral vertebrae in the study population is shown in Table 2. It was quite variable and extended between the middle of S2 and mid-S5. The S4 vertebra (69.9%) was the most dominant level. In 2.4%, the wall was open. The results of the present study in comparison (Table 9) agreed with studies by Ramamurthi and Anil[9] and Seema et al[6] as well as standard Anatomy textbooks.[1]

Level of Base

In the study population, Table 3 showed the various levels of base with respect to the sacral vertebrae. The most dominant level was the S5 (88%) vertebra. In 2.4% of the sacra, the sacral hiatus was completely obliterated and the lower end of the canal was closed due to bony undergrowth. Comparison with other studies supported the fact that the level of base was at the S5 vertebra in most of the population (Table 10).

Length, transverse width and anteroposterior diameter at apex

The results are shown in Table 4. The mean length and mean transverse width were 20.05mm and 12.35mm respectively. The anteroposterior diameter at apex of sacral hiatus is important as it should be sufficiently large to admit a needle, and varying diameters could cause subcutaneous deposition of anaesthetic drug. In the present study, mean anteroposterior diameter was 5.52mm.

Table 5 showed the mean length, transverse width and anteroposterior diameter of the sacral hiatus according to its shape. Analysis of variance (ANOVA) indicated significant variations in length ($F = 4.32$; $P = 0.003$) among the different shapes. On the other hand, no significant differences were observed in transverse width ($F = 2.41$; $P = 0.057$) and in the anteroposterior diameters ($F = 1.22$; $P = 0.309$) of the various shapes.

The mean length, transverse width and anteroposterior diameter of sacral hiatus according to the level of apex is seen in Table 6. Analysis of variance (ANOVA) showed significant variations in length ($F = 22.37$; $P = 0.000$) and transverse width ($F = 3.42$; $P = 0.021$) among the different levels. No significant difference ($F = 1.93$; $P = 0.132$) was observed in the anteroposterior diameter of the various levels.

In

Table 7, the mean length, transverse width and anteroposterior diameter of the sacral hiatus according to the level of base is determined. Analysis of variance (ANOVA) indicated no significant variations in length ($F = 1.56$; $P = 0.217$), transverse width ($F = 1.29$; $P = 0.280$) and the anteroposterior diameter ($F = 0.70$; $P = 0.498$) among the different levels.

Table 8: Incidence of various shapes of sacral hiatus in dry human sacral bones by various authors

Shape	Seema et al (2013)	Shewale et al (2013)	Anil et al (2013)	Current Study (2013)
Inverted U	42.95%	40.69%	31%	48.20%
Inverted V	27.52%	32.35%	25.80%	34.90%
Irregular	16.11%	9.31%	20.60%	4.8%
Dumbbell	13.42%	5.89%	5%	4.8%
Bifid	-	-	-	4.8%
Complete spina bifida	-	0.98%	-	1.2%
Elongated	-	9.31%	17.20%	-
Absent	-	0.98%	-	1.2%

Table 9: Incidence of level of apex of sacral hiatus in dry human sacral bones recorded by various authors

Level	Anil et al (2013)	Seema et al (2013)	Shewale et al (2013)	Current Study (2013)
S2	7.76%	4.03%	4%	2.40%
S3	41.38%	35.57%	15%	20.50%
S4	50.86%	56.37%	66.50%	69.90%
S5	-	4.03%	14.50%	4.80%

Table 10: Incidence of level of base of sacral hiatus in dry human sacral bones reported by various authors

Level	Anil et al (2013)	Seema et al (2013)	Shewale et al (2013)	Current Study (2013)
S4	18.97%	13.42%	2%	2.4%

S5	72.41%	70.47%	82%	88%
Coccyx	8.62%	16.11%	16%	7.2%

CONCLUSION

Information obtained from studies on anatomical variations of the sacral hiatus is important in caudal epidural block (CEB). In the present study, 83 dry human sacra were studied and the irregular, bifid and dumbbell shapes were 4.8% each. The sacral hiatus was completely absent in 1.2% and 1.2% had spina bifida, bringing the total rate of sacral hiatus abnormalities to 16.9%. The rate should be kept in mind when administering caudal epidural anaesthesia in the Nigerian population.

REFERENCES

1. Williams PL (ed). Gray's Anatomy, 38th edition, Churchill Livingstone, 2000; 592-31, 673-74.
2. http://www.MedicineNet.com. The Sacrum The Holy Bone, 2003. Accessed 15th June, 2013.
3. Senoglu N, Senoglu M, Oksuz H, Gumusalan Y, Yuksel KZ, Zencirci B et al. Landmarks of the hiatus for caudal epidural block: An anatomical study. British Journal of Anaesthesia. 2005; 95 (5):692- 695.
4. Edwards WB, Hingson RA. Continuous caudal anesthesia in obstetrics. American Journal of surgery. 1942; 57:459-464.
5. Sekiguchi M, Yabuki S, Satoh K, Kikuchi S. An Anatomic study of the sacral Hiatus: A Basis for successful caudal epidural Block. Clinical Journal of Pain. 2004; 20(1): 51-54.
6. Tsui BC, Tarkkila P, Gupta S, Kearney R. Confirmation of caudal needle placement using nerve stimulation. Anaesth Analg 1999; 91:374-8.
7. Seema, Singh M, Mahajan A. An anatomical study of variations of sacral hiatus in sacra of North Indian origin and its clinical significance. Int. J. Morphol., 2013; 31(1):110-114.
8. Shewale SN, Laeeque M, Kulkarni PR, Diwan CV. Morphological and Morphometrical Study of Sacral Hiatus. International Journal of Recent Trends in Science And Technology. 2013; 6(1):48-52.
9. Vijisha P, Baskaran S. Morphometrical analysis of sacral hiatus and its clinical significance. The Health Agenda, 2013; 1(1): 10-14.
10. Ramamurthi KS, Anil KR. Anatomical study of sacral hiatus for successful caudal epidural block. Int J Med Res Health Sci, 2013; 2(3):496-500