Available online at http://www.ijims.com
ISSN - (Print): 2519 – 7908 ; ISSN - (Electronic): 2348 – 0343
IF:4.335; Index Copernicus (IC) Value: 60.59; UGC Recognized -UGC Journal No.: 47192

A Study of Variations in Sacral Hiatus and Its Clinical Significance

Babita Kujur[1]*,Manisha R. Gaikwad[2]

1.Senior Resident and 2. Additional professor & Head

Department of Anatomy, All India Institute of Medical Sciences, Bhubaneswar, Odisha, India

*Corresponding Author: Babita Kujur

Abstract

The variations of sacral hiatus in dry bone are important as it determines access of sacral hiatus for caudal epidural anesthesia and analgesia. So the present study was conducted on 44 adult dry sacra in department of Anatomy, All India Institute of Medical Sciences,Bhubaneshwar,Odisha,India with the aim to find out the anatomical variations of sacral hiatus(SH) including shape, length, anteroposterior (A-P) diameter at apex and transverse width at base , distance from apex of sacral hiatus to foramina of S2 vertebra and the equilateral triangle formed between the apex of sacral hiatus and the two superolateral sacral crest. Most commonly found shape of sacral hiatus in this study was inverted U/V shape. The most common composition of sacrum in our study was 5 segments in 34 (77.27%) followed by 6 segments having sacralisation in 7(15.91%) and coccyx ankylosis in 3(6.82%). The sacral index in males was 92.42±8.20 and in females 118.81±3.77, which was statistically significant ($p<0.0001$).Most common position of apex and base of sacral hiatus was at the level of $4^{th}$and 5^{th} sacral vertebra respectively. The mean length, width and AP diameter at the apex of sacral hiatus were20.42±8.75, 12.31±2.87 and4.89±1.25mmrespectively.It can be concluded that anatomical variations in sacral hiatus are cause of caudal epidural anesthesia failure and procedure related complications. Understanding these variations may improve success of caudal epidural anesthesia and decrease incidence of complications. So this study will be useful to increase success rate of epidural anesthesia.

Keywords: sacrum,sacral index, sacral hiatus, caudal epidural block

Introduction

The sacrum is a large, flattened, triangular bone formed by the fusion of five sacral vertebrae. It forms the posterior part of the bony pelvis, articulating on each side with the corresponding hip bone at the sacro-iliac joint[1].The sacrum has a base, an apex, pelvic and dorsal surfaces. The dorsal surface (facies dorsalis) is irregular and convex.The inferior articular processes of the fifth sacral vertebra are free and form the sacral cornua, which project downwards at the sides of the sacral hiatus (hiatus sacralis).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 4^{th}) sacral vertebra. It is located inferior to the 4^{th} (or 3^{rd}) fused sacral spines or lower end of median sacral crest.[2] On the body surface the hiatus can be marked two inches above the tip of coccyx beneath the skin of natal cleft[1,2,3]. The hiatus is covered posteriorly by skin, a subcutaneous fatty layer and the sacrococcygeal membrane (Sekiguchi et al, 2004)[4].When the needle is passed through sacrococcygeal ligament the hiatus communicates with the epidural space. The dural sac ends at the level of the second sacral vertebra[1]. The sacral canal below this level contains extradural fat, vertebral venous plexus, lower sacral nerve roots and the filum terminale(Waldman[6], 2004; Ellis[5], 2006). Sacral hiatus has been utilized for administration of epidural anaesthesia in obstetrics (Edward and Hingson, 1942)[7]as well as in orthopaedic practice for transpedicular and lateral mass screw placement (Sekiguchi)[4]. The reliability and success of caudal epidural anesthesia depends upon anatomical variations of sacral hiatus as observed by various authors (Sekiguchi[4], Trotter[8]and Lanier, 1945; Trotter[9], 1947; Kumar et al[10], 1992; Chen et al[11], 2004; Aggarwal et al [12], 2009). The present study was undertaken to find out the anatomical variations of the sacral hiatus in dry adult human sacra of unknown origin, in the form of shape, length and breadth and antero- posterior diameter of the sacral hiatus at the apex.

Materials and methods

The present study was carried out in 44 dry adult human sacra belonging to skeletons of unknown age, gender and stature. The gender was determined on the basis of sacral index which was calculated using the formula (maximum width of sacrum/maximum height of sacrum x 100). The sacra having the sacral index ≤ 105 were considered male and those having sacral index ≥ 115 were considered female.The sacra were collected by simple random method from the Department of Anatomy and 1st year MBBS students of All India Institute of Medical Sciences, Bhubaneswar, Odisha. The measurements were done on intact parts of the normal bones**(fig. no. 1, 2 and 3**).The different parameters of each sacrum were studied under the following headings:-

a) composition of the sacrum
b) Shape of Sacral Hiatus was noted by naked eye experience.
c) Level of apex of Sacral Hiatus was noted with respect to sacral vertebra.
d) Level of base of Sacral Hiatus was noted with respect to sacral vertebra.
e) Length of Sacral Hiatus was measured from apex to mid-point of base.
f) Width of Sacral Hiatus was measured between the two sacral cornua (intercornual distance) .
g) Antero-posterior diameter of Sacral Hiatus at the apex.
h) Distance between apex of sacral hiatus and at the level of second sacral foramina.
i) Distance between apex of sacral hiatus and right and left supero-lateral crests.
j) Distance between two supero-lateral crests.

All these parameters were taken with the help of digital Vernier caliper with an accuracy of 0.01mm.

Statistical analysis: Data collected was tabulated and separated into two groups (male and female) on the basis of sacral indices in Microsoft excel sheet and was analyzed by Graph pad prism Software. The mean and standard deviation (SD) for each of the measurements were assessed. A comparison of the values of all measurements was made among groups using Student's t test. Differences among groups were considered statistically significant at p values of less than 0.05.

Results

*Composition of sacrum:*The most common composition of sacrum was 5 segments in 34 (77.27%) followed by 6 segments having sacralisation in 7(15.91%) and coccyx ankylosis in 3(6.82%) **(Table no. 1)**.

Sacral Index: The **table no.2** shows the maximum width, height and sacral indices in total, male and female sacra.The maximum width of sacrum in male is 99.07±4.27mm and in female was 100.06±8.50mm.The maximum height of the sacrum in male was107.64±6.82 mm and in female 84.37±8.78mm. The sacral height is greater in male than female, which was statistically significant ($p<0.0001$). The sacral index in males was 92.42±8.20mm and in females 118.81±3.77mm, which was highly statistically significant ($p<0.0001$).

Shape of sacral hiatus: Regarding various shapes of sacral hiatus, five different shapes were found in our study **(table no. 3) (figure no.4)**. The most common was inverted "U" found in 20 cases (44.44%), followed by inverted "V" in 11 cases (24.44%), irregular in 7(15.56%), dumbbell in 4(8.89%) and bifid in 2(4.44%). In one case there was complete agenesis of dorsal wall of the sacrum. This sacrum was excluded from the measurements as typical sacral hiatus was not present in it.

*Location of apex and base :*The levels of the apex and base of each SH(sacral hiatus) were determined according to the sacral and coccygeal vertebrae .The most common location of the apex of sacral hiatus was at the level of 4th sacral vertebra in 31(70.46%) followed by 3rd sacral vertebra in 12 cases (27.27%) and2nd sacral vertebra in one case (2.27%). The **table no.4** shows the different levels of apex of sacral hiatus. The 5th sacral vertebra was the most common level for base of sacral hiatus in all groups of sacra. The **table no. 5** shows the different levels of base of sacral hiatus.

Antero-posterior(AP) Diameter of sacral hiatus (SH)at the Apex : The values of AP diameter of SH at apex were 4.89±1.25mm in total, 4.82±1.46mm in male sacra and 4.62±1.14mm in female sacra **[Table no. 6]**. In 4.44% of cases the AP diameter at the apex ranged between 2 to 3 mm, in 51.11% of cases it ranged from 3.1 to 5mm, in 40% of cases it ranged from 5.1 to 7 mm and in 4.44% of cases it ranged from 7.1 to 9mm.**Table no. 6** also showed the mean and standard deviation of SH length, transverse

width of its base, linear distances between its apex and other bony landmarks (S2 foramina, right and left supero-lateral sacral crests), and the linear distance between the right and left supero-lateral sacral crests in the total, male, and female sacra. The length and width of sacral hiatus was greater in male, which was statistically significant ($p<0.0006$). Other parameters showed no significant difference between male and female sacra. The triangle between the two supero-lateral sacral crests and the SH apex was almost equilateral in all groups.

Discussion

Sacral hiatus has been utilized for administration of epidural anesthesia in obstetrics as well as in orthopedic practice for treatment and diagnosis (Edward[7] et al1942,Sekiguchi M [4]et al, 2004). The reliability and success of caudal epidural anesthesia depends upon anatomical variations of sacral hiatus .Less than 3 mm depth of sacral hiatus causes difficulty in the insertion of the needle. Its different shapes, surrounding bony irregularities and defects in dorsal sacral canal should be studied in order to avoid failure of epidural block. Hence detailed knowledge of sacral hiatus is essential[13]. Failure rate of caudal epidural anesthesia is 35% which is mainly due to anatomical variations of sacral hiatus and surrounding structures [14].Ultrasonography or fluoroscopy is 100% successful in caudal epidural block (Stitz and Sommer, 1999)[15]. But it is not always possible due to time, cost and personal availability, so knowing the anatomical variations of the sacral hiatus will facilitate the procedure .The present study was done to find out the anatomical variations of sacral hiatus.

Composition of sacrum : In present study, sacrum was composed of 5 segments in 34 (77.27%) followed by 6 segments having sacralisation in 7(15.91%) and coccyx ankylosis in 3(6.82%).Our study was similar to Arora S etal[16] and Chabra Netal[17] , Vinod K et al [10], Shewale et al [18] and William etal[19],they had noted 5 segmented sacra in 61(70.11%) ,24(75.0%),141(69.80%) , 69.6% and 56 (74.66%) cases respectively.William et al 19 observed partial or complete sacralisation of 5th lumbar vertebra in 9.33% of cases , which was lower than our study and coccygeal ankylosis in 10.66% of cases which was higher than our study. Trotter[8] and Lanier[20]observed sacralisation of 5th lumbar vertebra and coccygeal ankylosis in 12.6% and 39.3% respectively which are higher than our study .Vinod K et al [10] and Shewale et al [18] noted partial or complete sacralisation and coccygeal ankylosis in 1.48% and 2.25 %cases respectively and their finding was lower than our study.

*Sacral index:*In the present study, the mean sacral index was 105.41% in the total sample of sacra, 92.42% and 118.81% in male and female sacra, respectively. The mean sacral height and width in male and female sacra was 107.64±6.82, 99.07±4.27 and 84.37±8.78,100.06±8.50 respectively. The male sacra had significantly more height and width than female sacra. These findings were in agreement with Mohamed S.Mustafa et al (2012)[21],Mishra[22] et al, (2003), Standring et al. (2005)[1] and Marina et al (2008)[23]

*Sacral hiatus :*The knowledge of SH anatomy is imperative in clinical situations requiring Caudal epidural block for various diagnostic and therapeutic procedures of the lumbosacral spine to avoid failure and dural injury[12] . The SH is variable in shape and size. The laminae of the entire fifth sacral vertebra may fuse in the midline resulting in the absence of SH or it may fail to fuse resulting in incomplete bony dorsal wall of the sacral canal. Between these two extremities a number of variations in the SH have been observed [24].In the present study five different shapes of sacral hiatus were encountered , namely inverted V, inverted U, irregular, dumbbell and bifid. Inverted ‘U’ in 44.44%cases while Inverted ‘V’ shaped sacrum was found in 24.44% cases. These two shapes provide enough room for introducing needle into sacral canal without any obstacle and thus may be the most favorable shapes for CEB. The other shapes found in the present study were irregular, dumbbell and bifid in 15.56%,8.89% and 4.44% of cases respectively and complete agenesis of dorsal wall in 1(2.22%) case. The findings of the present study are similar to Shinde AA et al[25] in northern and Dona et al [26] in Benagali population found most common U shape sacral hiatus in 56.00% and 70.09% respectively while that of Chabra N et al [17], Arora S et al [16], Vinod K et al [10] and William FM et al [19] who found Inverted ‘V’ and Inverted ‘U’ shapes in 29.12%% and 22.40% cases, 43.75% and28.12%, 46.53% and 29.7%, 42.75% and 30.25% cases respectively. Complete agenesis of the dorsal bony wall of the sacral canal or spina bifida occurs due to failure in complete fusion of sacral vertebrae. In spina bifida caudal epidural block is still possible. In the present study spina bifida or complete agenesis of the sacral hiatus was found in one sacra in 2.22% which are in accordance with William FM et al[19],

Nagashree MV et al[27] and A Bharti et al(2016)[28]who observed absence of sacral hiatus and complete spina bifida in 1.9%% and 1.7% cases respectively.

Apex of sacral hiatus: In the present study most common location of the apex of sacral hiatus was at the level of S4 vertebra in 31(70.46%) cases, at the level of S3in 12(27.27%) and in 1(2.27%) at 2nd sacral vertebra. The findings are in accordance with the studies done by William FM et al[19] and A. Bharathietal[28] , Chabra N et al [17] and Dona S et al [26],Vinod K et al[10],Nagar SW[29]et al and Sekiguchi M et al[4]. Apex of sacral hiatus is an important landmark for carrying out successful caudal epidural block. It shows considerable variation ranging from S2 to S4. When the apex of sacral hiatus is located at 2nd or 3rd sacral vertebra, there are more chances for the puncture of dural sac during caudal epidural block. If the apex is higher, more precaution should be taken while deciding length of the needle to be introduced into the canal.

Base of sacral hiatus: In the present study, base of the sacral hiatus in 41(91.18%) sacrum was seen at the level of 5thsacral vertebra, in 2(4.54%) at 4thsacral vertebra and in 1(2.27%) at coccyx C1 .The findings of the present study are more or less in agreement with those of others authors namely Mustafa [21]et al, A. Bharathi et al [28] and Dona S et al [26] they found the base at 5thsacral vertebra in 91% , 61.40% and 95.7% cases respectively. The location of sacral hiatus apex was more variable than its base in all examined sacra so insertion of a needle into the sacral hiatus for caudal epidural block is suggested to be done at its base to avoid the anatomic variations of its apex.

Length of sacral hiatus: In the present study the mean length of the sacral hiatus was 20.42±8.75mm, 25.96±8.79 and 22.24±6.32 mm in total, male and female respectively. These findings are similar to the studies done by Trotterand Lanier (1945)[20] reported a mean hiatal length of 24.8 mm in American males and19.8 mm in females. Similar results were observed by earlier studies of Trotter and Letterman (1944)[24] in which the length of the hiatus varied from 0-66 mm with a mean of 22.5 mm .Other authors like Vinod Kumar et al[10], Nagar SK[29],William FM et al[19] and Mustafa et al[21] reported similar result. The present and previous studies showed that the increase in length of hiatus is influenced by the defect and non-union of 2nd or 3rd pair of sacral lamina and also by coccygeal ankylosis.

Width of sacral hiatus at the base: In the present study the mean breadth at the base of sacral hiatus was12.31±2.87, 15.74±1.35and13.59±2.49mm in total, male and female respectively. Similar results were reported by A. Bharathi[28] who found mean transverse width of 13 mm with a range of 11-20 mm(90%) and 1-10 mm (5%) and 21-30mm (5%) ,ChabraN et al [17] and Arora et al [16] who observed mean breadth 12.84 mm range from 6.53-16.99 mm and mean transverse width of 11.95±2.78 mm. respectively. Aggarwal et al[21] gave it as11.95+2.78 mm , Sekiguchi et al[4] have reported a lower figure of 10.2 ± 0.35 mm. Trotter8 and Letterman[24] who noted higher value of the width at base to vary from 7-26 mm with mean of 17 mm, Lanier et al 20 who reported mean width at base to be 19.3 ± 0.3 mm and Kumar et al [10](2009) who reported 5-20 mm (13 mm in mean) and 8-18 mm (12.5 mm mean) in male and female sacra of his series.

Antero-posterior (AP)diameter of sacral hiatus(SH) at the apex. The anteroposterior diameter of sacral canal at apex of sacral hiatus is important as it should be sufficiently large to admit a needle. Varying diameters lead to subcutaneous deposition of anaesthetic drug. In the present study the anteroposterior diameter ranged from 2 to 9 mm, with a mean of 4.89±1.25,4.82±1.46 and4.62±1.14 mm in total, male and female respectively. These values were similar with those reported by Trotter et al[8](1944), 5.3mm, Lanier et al[20] (1944), 6.1mm , Trotter [9](1947), 0.5 cm in whites and 0.6 cm in Negro sacra, Kumar et al[10] (1992), 4.8 mm, Nagar et al[29](2004), 4.8 mm, Sekiguchi et al[4] (2004), 0.6 cm, Senoglu et al[30] (2005), 4.46 mm, Aggarwal et al [12](2009), 5.0 mm, and Mustafa et al [21](2012),4.8mm.

Distance from apex of sacral hiatus to the level of S2 sacral foramina: An important point in caudal epidural block is awareness of the distance between the sacral hiatus and dural sac anatomically in relation to the risk of dural puncture. The level of S2 foramina is important because in adults duramater and arachnoid end at the level of second sacral vertebra.[10]Hence this distance decides the length of the needle that can be safely introduced into the canal. The mean distance from apex to S2 in present study was 38.07±10.16, 33.66±8.07 and36.49±3.57 mm in total, male and female sacra respectively. Our finding was similar to Senogluet al[30] (2005), 35.4±10.4 mm and Mustafa et al [21](2012),41.0±11.4mm. Hence from this data it would be safer to

advance the needle only few millimetres (<5mm) after penetrating the sacrococcygeal membrane during caudal epidural block in adults [11,23] and it is more safe to introduce it through the base in order to reduce the frequency of dural puncture.

The apex of the sacral hiatus is an important bony landmark in the success of CEB but it may be hard to palpate, particularly in obese patients. Hence other prominent anatomic landmarks may be of use, such as the triangle formed between the posterior superior iliac spines and the apex of SH. Abd El-Monem et al. (2006)[31] studied the SH in Egyptian dry sacra and cadavers. They noticed 3 surface depressions on the lower part of the back of human body, which formed an equilateral triangle. The base of that triangle was formed by the upper 2 depressions that represented the 2 posterior superior iliac spines. Its apex was directed below and pointed to the sacral hiatus. The equilateral triangle could be useful in confirming the palpation of the sacral cornua and hence the base of the SH. Senoglu et al[30] (2005) stated that the posterior superior iliac spines impose on the superolateral sacral crests of the sacrum, and they used them as landmarks in identifying the equilateral triangle in dry sacra. They found that the average distance between the 2 superolateral sacral crests (the base of the triangle) was 6.65±53.5 cm (range, 5.1–7.95 cm). The distance between the right superolateral sacral crest and the sacral apex was 6.71±1.0 cm (range, 4.21–8.9 cm). The distance between the left superolateral sacral crest and the sacral apex was 6.75±9.5 cm (range, 4.6–8.81 cm).

In the present study, the distance between the right and left superolateral crests was 62.60±5.58, 59.06±5.26 and 66.34±5.17mm in the total, male, and female sacra, respectively.Whereas the distance between right superolateral sacral crest and SH apex was 64.02±9.19,63.51±5.87 and 67.46±4.57mm in the total, male and female sacra respectively. The distance between left superolateral sacral crest and SH apex was 64.37±9.77,61.85±4.89 and 67.30±5.79mm in total, male and female respectively. The apex of sacral hiatus, right and left superolateral sacral crests in the present study, formed equilateral triangle, as the linear distance between these points were almost equal.These results were in agreement with those of Senoglu et al[30] (2005), Abd El-Monem et al[31] (2006) and Mustafa et al [21](2012).

Conclusion

The knowledge of anatomical variations of sacral hiatus is important to improve the success rate of caudal epidural anesthesia. So this study gives information about the variations of sacral hiatus with respect to its shape, length width, AP diameter at the apex and the various bony landmarks, which will be helpful especially for anesthetists, surgeons and gynecologists (spinal analgesia) while giving caudal epidural block.

References

1. Standring S, “The Back” in Gray’s Anatomy: The Anatomical Basis of Clinical Practices, Standring S, Ellis H, Healy JC et al., Grays Anatomy. 40 th Edition. Elsevier. Churchill Livingstone. New York, NY, USA, 2008; 724-28.
2. Keith L. Moore, “Back” in clinically oriented anatomy. 7 [2] th Edition. Lipincott, Williams Wilkins. Philadelpia. 2014;451-54.
3. Peter L William et al. Gray’s anatomy 38 th edition. ChurchLivingston 2000;592-531 and 673-674.
4. Sekiguchi M, Yabuki S, Saton K, Kikuchi S. An anatomical study of the sacral hiatus: a basis for successful caudal epidural block. Clin. J. Pain. 2004;20(1): 51-54.
5. Ellis, H. The sacrum and the caudal block. Anaesth. Intensive Care Med., 7(11):397-98, 2006.
6. Waldman, S. D. Caudal epidural nerve block: prone position. In:Atlas of Interventional Pain Management. 2 nd Ed. Philadelphia,Saunders, 2004. pp.380-92.
7. Edwards WB, Hingson RA. Continuous caudal anaesthesia in obstetrics. American journal of surgery 1942;57:459-464.
8. Trotter M, Lanier PF. Hiatus canalissacralis in American whites and Negros. Human Biology 1945; 17: 368-381.
9. Trotter M. Variations of the sacral canal; Their significance in the administration of caudal analgesia. Anesthesia and analgesia 1947; 26 (5): 192-202.
10. Vinod K, Pandey SN, Bajpai RN et al. Morphometric study of sacral hiatus. J AnatSoc India 1992;41(1):7-13.

11. Chen, P. C.; Tang, S. F.; Hsu, T. C.; Tsai, W. C.; Liu, H. P.; Chen,M. J.; et al., Ultrasound guidance in caudal epidural needleplacement. Anesthesiology, 101(1):181-4, 2004.
12. Aggarwal A, Kaur H, Batra YK, Aggarwal AK, Rajeev S, Sahni D. Anatomic consideration of caudal epidural space: A cadaver study. Clin Anat. 2009;22:730–7.
13. Aggarwal A, Aggarwal A, Harjeet, Sahni D. Morphometry of sacral hiatus and its clinical relevance in caudal epidural block. SurgRadiol Anat. 2009 Dec;31(10):793-800. doi: 10.1007/s00276-009-0529-4. Epub 2009 Jul 4. PubMed PMID: 19578805.
14. Mayuri J, Vijay G, Vasudha N, Anita G, Asha P. Anatomical Study Of Sacral Hiatus In Dry Isolated Sacra. J Res Med Den Sci. 2014; 2(2): 43-46. doi:10.5455/jrmds.20142210
15. Stitz, M. Y. and Sommer, H. M. Accuracy of blind versus fluoroscopically guided caudal epidural injection. Spine,24(13):1371-6, 1999.
16. Arora S, Dhingra R, Malik V S , Garsa V, Chhabra S :Study of Various Shapes of Sacral Hiatus in North Indian Population.International Journal of Science and Research (IJSR) (2016)Volume 5 Issue 10, October 1328-32.
17. Chhabra N. An anatomical study of size and position of sacral hiatus; its importance in caudal epidural block. Int J Health Sci Res. 2014;4(12):189-196.
18. Shewale SN, Laeeque M, Kulkarni PR et al. Morphological and morphometrical study of sacral hiatus. Int J Recent Trends in Sciand Tech 2013; 6(1):48-52.
19. William FM,JaiswalP,GuptaS,KoserT,Rathore KB. Morphometric Study of Sacral Hiatus in Central Part of Rajasthanand its Correlation with Caudal Epidural Block. IOSR Journal of Dental and Medical Sciences (IOSR-JDMS) e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 16, Issue 4 Ver. VIII (April. 2017), PP 123-131.
20. Lanier VS, McKnight HE, Trotter M. Caudal analgesia: An experimental and anatomical study. America journal of Obstetrics and Gynaecology 1944;47 (5);633-641.
21. Mustafa MS, Mahmoud OM, El Raouf HH, Atef HM. Morphometric study of sacral hiatus in adult human Egyptian sacra: Their significance in caudal epidural anesthesia. Saudi J Anaesth. 2012 Oct-Dec;6(4):350-7.
22. Mishra SR, Singh PJ, Agrawal AK, Gupta RN. Identification of sex of sacrum of Agra region. J AnatSoc India. 2003;52:132–6.
23. Marina B, Ferdose S, Fauzia F. Sex differences in sacra in the Punjab region. Biomedica. 2008;24:152–7.
24. Letterman GS, Trotter M. Variations of the male sacrum; Their significance in caudal analgesia. Surg. Gynaecol. Obstet. 1944;78 (5) ; 551 – 555.
25. Shinde AA, Manvikar PR, Bharambe VK; Morphometric study of sacral hiatus and its significance in caudal epidural anaesthesia.(2015) Sahel Med J;18:134-8.
26. Dona S, SantanuB ,Akhtar U, Sibani M, Ardhendu M :Morphometry of sacral hiatus for epidural block (2016) Italian Journal of Anatomy and Embryology Vol . 121, n. 2:PP165-171.
27. Nagashree MV, Pai V, Gireesh: An anatomical study of sacral hiatus in human dry sacra. Research Journal of Pharmaceutical, Biological and Chemical Sciences 2014; 5(2):1195-9.
28. A. Bharathi, V. Janaki, Veenatai. J :Morphometric variations in sacral hiatus in Telenganaregion.International Journal of Anatomy and Research, (2016), Vol 4(2):2175-78.
29. Nagar SK. Shah Medical College, Jamnagar, Gujarat: A study of sacral hiatus in dry human sacra. J AnatSoc India. 2004;53:18–21.
30. Senoglu N, Senoglu M, Oksuz H, Gumusalan Y, Yukse KZ, Zencirci B, et al. Landmarks of the sacral hiatus for caudal epidural block: An anatomical study. Br J Anaesth. 2005;95:692–5.
31. El-Monem AH, Neven MG. A morphological study of the sacral hiatus. Zagazig University Medical Journal (ZUMJ) 2006;12:2877–86.

TABLES and FIGURES

Table no.1: Showing sacral composition

Sl. no.	Sacral composition	No. of sacrum	Percentage%
1	5 segments	34	77.27
2	6 segments(sacralisation)	7	15.91
3	6 segments (coccygeal)	3	6.82
4	total	44	100

Table no.2:Showing various parameters of sacrum and sacral index

Sl. no.	Parameters	Total(n±SD)	Male(n±SD)	Female(n±SD)
1	Maximum width	102.56±7.52	99.07±4.27	100.06±8.50
2	Maximum height	98.69±12.37	107.64±6.82	84.37±8.78
3	Sacral index	105.41±14.05	92.42±8.20	118.81±3.77

Table no.3: Showing Percentage of various shapes of sacral hiatus

Sl. no.	Shape of sacral hiatus	Total		Male		Female	
		No.	%	No.	%	No.	%
1	Inverted U	20	44.44	9	32.14	11	64.70
2	Inverted V	11	24.44	8	28.57	3	17.65
3	Irregular	7	15.57	5	17.86	2	11.77
4	Dumbbell	4	8.89	3	10.71	1	5.88
5	Bifid	2	4.44	2	7.14	0	0
6	Agenesis	1	2.22	1	3.58	0	0
Total		45	100	28	100	17	100

Table no.4: Showing location of apex of Sacral Hiatus (SH) with respect to the level of the sacral vertebra

Sl. no.	Location of apex of SH	Total		Male		Female	
		n	%	n	%	n	%
1	2 sacral vertebra	1	2.27	1	3.70	0	-
2	3sacral vertebra	12	27.27	7	25.93	6	35.29
3	4 sacral vertebra	31	70.46	19	70.37	11	64.71
Total		44	100	27	100	17	100

Table no.5: Showing location of base of SH with respect to the level of the sacral and coccygeal vertebrae

Sl. no.	Location of base of SH	Total		Male		Female	
		n	%	n	%	n	%
1	4 sacral vertebra	2	4.55	1	3.71	1	5.88
2	5 sacral vertebra	41	93.18	26	96.29	15	88.24
3	1 coccygeal vertebra	1	2.27	0	-	1	5.88
Total		44	100	27	100	17	100

Table no.6: Showing various parameters of sacral hiatus

Sl. no.	Parameters	Total	Male	Female
1	Length of SH	20.42±8.75	25.96±8.79	22.24±6.32
2	Width of SH at the base	12.31±2.87	15.74±1.35	13.59±2.49
3	Antero posterior diameter at apex of SH	4.89±1.25	4.82±1.46	4.62±1.14
4	Apex to foramina of S2	38.07±10.16	33.66±8.07	36.49±3.57
5	Apex to rightSuperolateral crest	64.02±9.19	63.51±5.87	67.46±4.57
6	Apex to leftSuperolateral crest	64.37±9.77	61.85±4.89	67.30±5.79
7	Distance b/w two superolateral crests	62.60±5.58	59.06±5.26	66.34±5.17

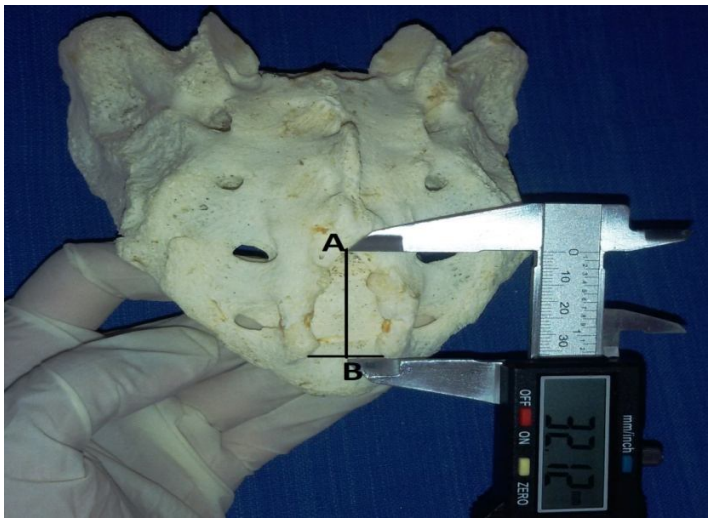

Fig.no. 1:Showing measurement of length of sacral hiatus [from apex (A) to midpoint of base of sacral hiatus (B)]

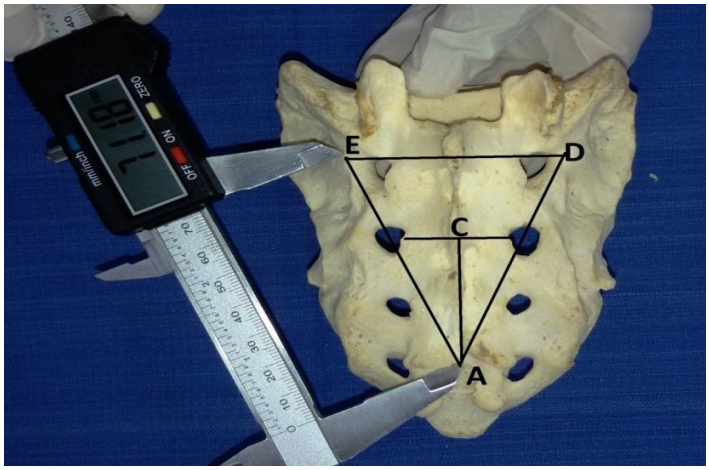

Fig. no. 2: Showing measurements of linear distance from apex to right supero-latarel crest(AD), apex to left supero-lateral crest (AE), apex to level of S2 sacral foramina (AC) and between two supero-lateral crests (ED)

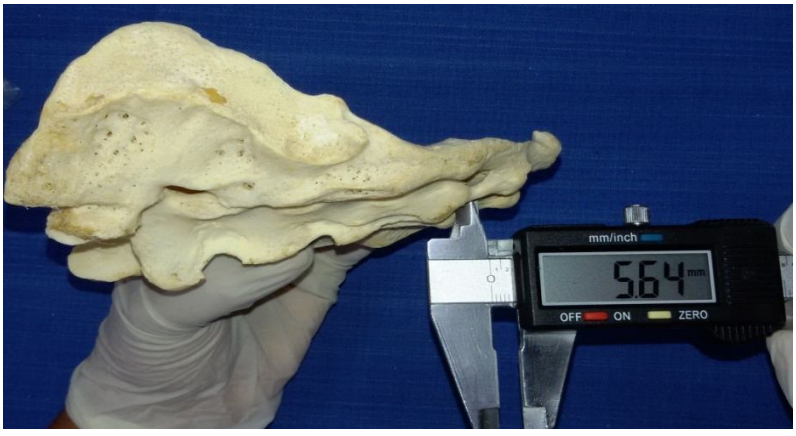

Fig. no. 3: Showing measurement of antero- posterior diameter at the apex of sacral hiatus

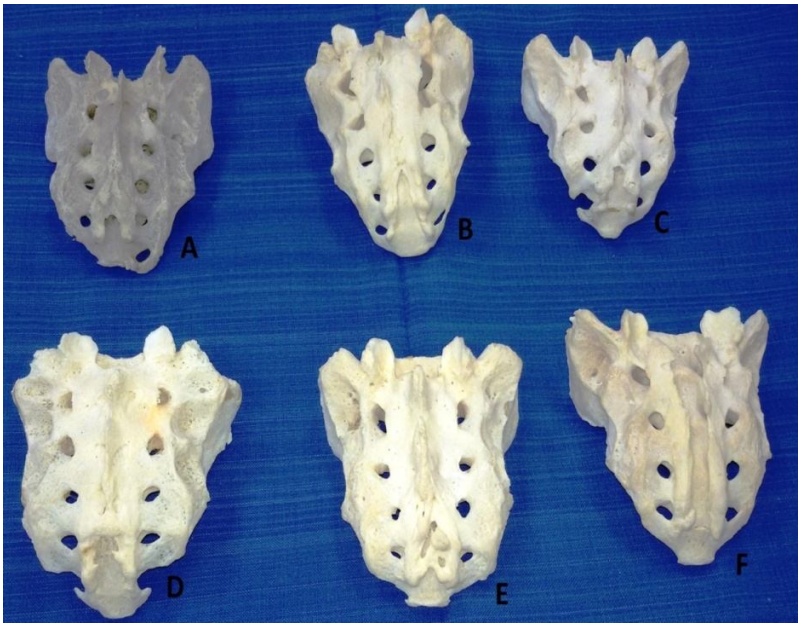

Fig.No. 4: Showing different shapes of Sacral Hiatus. A-Inverted "U", B-Inverted" V", C-Dumbbell shape, D-Irregular shape, E-Bifid and F-Complete Agenesis of dorsal sacral wall.