ORIGINAL ARTICLE

ANATOMICAL STUDY OF SACRAL HIATUS FOR CAUDAL EPIDURAL BLOCK

Patil Dhananjay S[1], Jadav Hrishikesh R[2] , Binodkumar[3], Mehta C D[4], Patel Vipul D[5]

[1]Associate Professor, Anatomy Department, GMERS Medical College, Valsad, [2]Professor & Head, Anatomy Department, GMERS Medical College, Sola, [3]Assistant Professor, [4]Professor and Head, Anatomy Department, Government Medical College, Surat, [5]Associate Professor, Anatomy Department. GMERS Medical College, Patan, Gujarat, India

Correspondence:
Dr. Dhananjay S. Patil, Email: ptldhnnjy@gmail.com

ABSTRACT

Introduction: Anatomy of the sacral hiatus is having clinical importance during caudal epidural block. Present study is aimed at determining anatomy of sacrum specially sacral hiatus for caudal epidural block, with the help of morphometric measurements of the sacrum in relation to sacral hiatus in dry sacral bones.

Material & method: Total 103 complete and undamaged adult, dry sacral bones were measured with Vernier caliper (accuracy 0.1 mm) and anatomical measurements were obtained.

Results: Three bones were excluded because of total posterior closure defect. Agenesis of the sacral hiatus was detected in three sacral bones. Right and left superolateral sacral crests of the sacrum were taken as two points on dorsal surface of sacrum (forming the base of a triangle) because posterior superior iliac spines impose on the superolateral sacral crests. The distance between the two superolateral sacral crests (base of a triangle), the distances between the right and left superolateral sacral crest and the sacral apex were on average 60.61(SD 6.71), 61.95 (11.71) and 61.4 (11.98) mm respectively..

Summary: An equilateral triangle formed between the apex of the sacral hiatus and right and left superolateral sacral crests. This equilateral triangle will help in determining the location of the sacral hiatus during caudal epidural block.

Keywords: Caudal epidural block; Sacrum, Sacral apex; Sacral hiatus

INTRODUCTION

For analgesia and anaesthesia in various clinical procedures, we need Caudal epidural block (CEB) which involves injection of a drug into the epidural space through the sacral hiatus .Sacrum is a triangular bone formed by fusion of five vertebrae and forms the posterosuperior wall of the pelvic cavity, wedged between the two hip bones. Its caudal apex articulates with the coccyx and its superior, wide base with the fifth lumbar vertebra at the lumbosacral angle. It is set obliquely and curved longitudinally, its dorsal surface being convex, the pelvic concave .The fifth inferior articular processes of sacrum project caudally and flank the sacral hiatus as sacral cornua,connected to coccygeal cornua by intercornual ligaments.It is an important clinical landmarks during CEB .Due to incomplete midline fusion of the posterior elements of the distal portion of the fifth or sometimes the fourth sacral vertebra sacral hiatus is inverted U-shaped space , covered by the posterior aspect of the sacrococcygeal membrane and is an important landmark in CEB.The hiatus is covered only by skin, a subcutaneous fatty layer and the sacrococcygeal membrane. The dural sac and subarachnoid space usually extends to the level of the S2 segment of the sacrum but the dural sac may ends as high as the L5 or to S3. In adults it is sometimes difficult to determine the anatomical location of the sacral hiatus and the caudal epidural space. The success rate of CEB is based on determination of the landmarks by the clinician. The main goal of this study was to find practical solution of this problem by identifying additional anatomical landmarks mainly of sacral cornua and measurements that may enhance the location of the apex of the sacral hiatus for CEB. Measurements on dry sacral bones determine anatomical landmarks that may be used during CEB procedures.

MATERIAL & METHOD

Total 103 complete and undamaged adult, dry sacral bones obtained from Government Medical College Surat were used in present study. The sex and age of bones was unknown. A Vernier caliper (accuracy 0.1 mm) was used for Anatomical measurements.Superolateral sacral crests of the sacrum

were used as landmarks in the measurements as the posterior superior iliac spines (palpable on the body surface of a patient) impose on the superolateral sacral crests of the sacrum and our measurements were carried out on dry sacral bones. The distances from the apex and base of the sacral hiatus to the level of the S2 foramina were also measured as the dural sac terminates around the level of S2.Total nine morphometric measurements relating to the sacral vertebra and hiatus, were obtained having importance for CEB, (Fig. 1)and (Fig.2).

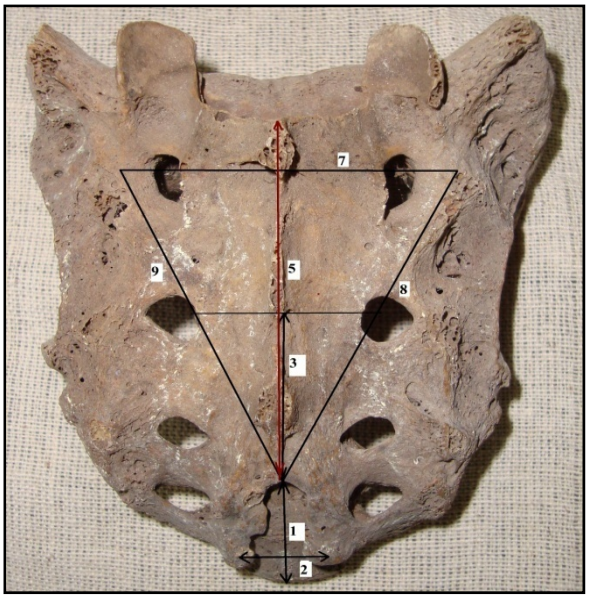

Fig 1: Morphometric measurements of sacrum

1 . Height of Sacral Hiatus; **2.** Width of Sacral Hiatus at level of sacral cornua; **3.** Distance from Hiatus apex to the level of S2 foramina; **4.** (4=1+3) Distance from base of sacral hiatus to the level of S2 foramina; **5.** Distance between the upper border of S1 and Sacral apex; **7.** Distance between two superolateral sacral crest(base of the triangle); **8.** Distance between right superolateral sacral crest and sacral hiatus apex; **9.** Distance between left superolateral sacral crest and sacral hiatus apex

Finally Statistical analysis and Data were expressed as mean (SD), median and range.Calculations and Analyses were performed using openoffice.org 3.2.0 spreadsheet software version for Linux (Ubuntu 10.04).

No complicated instruments required for this and thus it is a simple method. Human error during measurements may be a limitation of this method.

Fig 2: Depth of Sacral Hiatus at the level of its apex

RESULTS

Agenesis of the hiatus was detected in three sacrums.The average length of the sacral hiatus was 34.13 (11.82) mm (range 7–76 mm). The range of length of the sacral hiatus was mostly between 21 and 40mm (Table 1).Width of Sacral Hiatus at level of sacral cornua was 13.71 (2.24) mm (range 9–20 mm).

Table 1: Length of sacral hiatus

Range of Length (mm)	% of specimens
1–10	1
11 – 20	11
21–30	24
31–40	34
41–50	24
>50	6

Table 2: Morphometry of Sacrum

	Mean	SD	Median	Max	Min
Height of Sacral Hiatus (mm)	34.13	11.82	34	76	7
Width of Sacral Hiatus at level of sacral cornua (mm)	13.71	2.24	13.5	20	9
Distance from Hiatus apex to the level of S2 foramina (mm)	32.88	13.34	34.5	65	0
(4=1+3) Distance from base of sacral hiatus to the level of S2 foramina (mm)	67.01	12.08	66	103	41
Distance between the upper border of S1 and Sacral apex (mm)	64.77	17.07	65.5	109	17
Depth of Sacral Hiatus at the level of its apex (mm)	4.26	1.55	4	9	1
Distance between two superolateral sacral crest(base of the triangle) (mm)	60.61	6.71	60	78	43
Distance between right superolateral sacral crest and sacral hiatus apex (mm)	61.95	11.71	63	95	29
Distance between left superolateral sacral crest and sacral hiatus apex (mm)	61.4	11.98	63	91	28

The average distance between the two superolateral sacral crests (the base of the triangle) was 60.61 (6.71) mm (range 43–78 mm). The distance between the right superolateral sacral crest and the sacral apex was 61.95 (11.71) mm (range 29–95 mm). The distance between the left superolateral sacral crest and the sacral apex was 61.4 (11.98) mm (range 28–91 mm). From these mean values, we can note that the distances from the right and left sacral crests to the hiatus were nearly similar. The anatomical measurements and calculations are given in Table 2.

DISCUSSION

To reach into sacral caudal epidural space most frequently used technique is prone position of patient , table flexed or with pillow beneath pelvis .followed by palpation of cornu and hiatus with the help of left hand fingers. Needle is then inserted 2-3 mm at an angle of 45 degrees 'pops'through sacrococcygeal ligament. A failure rate of up to 41% has been reported by some authors,14.82% failure rate noted by Paolo Busoni et al[1]. in childrens. Shu-Yam Wong[2] reported a highest success rate 95.9% in adults while ultrasound guided needle placement sucess was 100% by Carl P. C. Chen[3].

Due to anatomical variation caudal epidural space is always difficult to identify for clinicians. The apex of the sacral hiatus is an important bony point for caudal epiduaral block but there may be difficulty in its palpation in some patients. Hence other bony landmarks should be used in relation with sacral hiatus, we can draw a triangle between the posterior superior iliac spines (superolateral sacral crest in dry sacral bones) and the apex of sacral hiatus. We measure distance between such points which can guide clinician for detection of sacral hiatus easily and increase the success rate of caudal epiduaral block. William R. Meeker[4] and colleagues noted that the diameter of sacral canal is 4.5mm. It is difficult to pass the needle into the sacral hiatus if it cannot be located accurately.

Variations in structure of sacral hiatus such as anteroposterior flattening, reduced in size by osseous bars passing from sacral to coccygeal cornua, Partial ossification of sacrum and coccyx, presence of an ossified sacrococcygeal ligament are found which close the sacral hiatus. Laminae of the last sacral segment never join forming partial or complete sacra bifida, Asymmetric sacrums are either of traumatic or pathologic origin . Various shapes of sacral hiatus were observed which included inverted U (41.5%), inverted V (27%), irregular (14.1%), dumbbell (13.3%) and bifid (1.5%) ,which cause failure of caudal epidural block. N. Senoglu et al[5]. reported that antero posterior diameter of the sacral canal at the apex of the hiatus was 2 mm in 6.25% of cases , I. M. Crighton et al [6] 2.70% and Trotter et al[7]. 2mm and less in 5.5% sacrum our series of 100 sacral bones, this diameter was 2 mm or less in fourteen (14%).

Standiford Helm II[8] in their study observed 3% hiatal agenesis , while completely fused walls at apex of sacral hiatus was observed by Trotter et al. in 0.74% sacrum In present study, total agenesis was not found in sacrum but depth of caudal canal was less than 2 mm at the level of hiatal apex in 2%. N. Senoglu et al[5] noted the distance between the sacral cornua [17.47 (3.23) (7–28) mm] and the depth of sacral hiatus [4.46 (1.33) (1–7)mm] smaller than those measured in our study [13.71 (2.24) (9–20) mm and 4.26 (1.55) (1–9)mm respectively] with more range in our study. This may be due to racial diversity as noted by Annemarie Norenberg. .

Addition measurements are Distance between two superolateral sacral crest (base of the triangle) [60.61 (6.71) 43-78mm], Distance between right superolateral sacral crest and sacral hiatus apex [61.95 (11.71) 29-95mm], Distance between left superolateral sacral crest and sacral hiatus apex [61.4 (11.98) 28-91mm] forming nearly an equilateral triangle between superolateral sacral crest and sacral hiatus apex in 29% sacrum.This equilateral triangle can act as guide to the location of the apex of sacral hiatus during caudal epidural block and one can avoid problem of failure in needle placement. Anjali Aggarwal et al. used posterior superior illiac spine (instead of superolateral sacral crest) and sacral hiatus get following values 70.1 (7.8), 66 (9.6), 65.3 (9.8) respectively and observed equilateral triangle in 51% specimens.

Ban C. H. Tsui[11] used low-current epidural stimulation to confirm the location of the epidural space to confirm caudal needle placement with 100% accuracy. , Shu-Yam Wong[2] reported a highest success rate 95.9% in adults while ultrasound guided needle placement sucess was 100% by Carl P. C.[3] Chen during caudal epidural block but ultrasonography or fluoroscopy is not always possible because of availability, cost and person may not be familiar with it. Caudal epidural injections are ideally performed with fluoroscopic guidance as the gold standard for accurate needle placement to decrease the risk of a subarachnoid puncture, decrease intrathecal or intravascular injection, and facilitate accurate delivery of injectate but 77% sucess noted by Laxmaiah Manchikanti[12] and others without fluoroscopy. The sacral cornua used in localizing the hiatus by clinicians may not be palpable in some patients and fluoroscopy may not possible. Anatomical knowledge of the sacral hiatus will help in caudal epidural block. Apex of the sacral hiatus may be above the distal third of S4 and dural sac usually terminates at lowerborder of S2 about 6 cm. from the sacral hiatus in adults .

The distance between the S2 foramen and the apex of the sacral hiatus was 35.4 (10.4) mm on average (range 11–62 mm) and the distance to the base of the sacral hiatus was 65.3 (9.4) mm (range 39–85 mm) i the study by Senoglu et al[5] while in present study it was 32.88 (13.34)mm (range 17–65 mm) and 67.01 (12.08) mm (range 41–103 mm) respectively which are nearer to observations by N. Senoglu et al[5] . To reduce the

frequency of dural puncture and other possible complications the needle should be cautiously advanced after penetrating the sacrococcygeal membrane. However total posterior closure defect was observed in 2.08% in . Senoglu et al and three of our sacral bones (2.91%). There is variability in the anatomical structure of the sacrum and the sacral hiatus in study by . William R. Meeker[4] and as noted in present study .Findings in present study shows that equilateral triangle, between the two posterior superior iliac spines (right and left superolateral sacral crest in dry bones) and the apex of the sacral hiatus will help in caudal epidural block for location of the sacral hiatus. In addition to this practical application of our data and anatomical knowledge for caudal epidural anesthesia is required to support.

REFERENCES

1. Paolo Busoni, Armando Sarti, Sacral Intervertebral epidural block. Anaesthesiology, 67, 1987, 993 – 995.
2. Shu-Yam Wong et al.,Caudal Epidural Block for Minor Gynecologic Procedures in Outpatient Surgery. Chang Gung Med J Vol. 27 No. 2,February 2004; 116-121
3. Carl P. C. Chen et al.,Ultrasound Guidance in Caudal Epidural Needle Placement.Anesthesiology 2004; 101:181– 4
4. William R. Meeker, Sacral nerve block aneshesia,The anatomy involved, technic and clinical application . Annals of Surgery,vol.80, issue 5 ,Nov1924;739-772
5. N. Senoglu, M. Senoglu, H. Oksuz1, Y. Gumusalan, K. Z. Yuksel, B. Zencirci,M. Ezberci and E. Kızılkanat,Landmarks of the sacral hiatus for caudal epidural block: an anatomical study. British Journal of Anaesthesia,September 2005;1-4
6. I. M. Crighton, B. P. Barry and G. J. Hobbs,A study of the anatomy of the caudal space using magnetic resonance imaging. British Journal of Anaesthesia 1997; 78: 391–395
7. Trotter, Mildred and Letterman, G. S., Variations of the female sacrum: their significance in continuous caudal anesthesia. Surg., Gynec. And Obst. 78, 1944; 419-424
8. Standiford Helm II,Jeffrey D. Gross and Kenneth G. Varley, Mini-Surgical Approach for Spinal Endoscopy in the Presence of Stenosis of the Sacral Hiatus. Pain Physician. 2004;7:323-325,1533-3159.
9. Annemarie Norenberg, Donald C. Johanson, J.S. Gravenstein, Racial difference in sacral structure important in caudal anesthesia. Anesthesia, 50, 1979;549-551
10. Anjali Aggarwal,Harjeet Kaur, Yatindra K. Batra,Aditya K. ,Subramanyam Rajeev and Daisy Sahni,Anatomic Consideration of Caudal Epidural Space: A Cadaver Study. Clinical Anatomy 22,2009;30–737
11. Ban C.H. Tsui, Pekka Tarkkila, Sunil Gupta, Ramona Kearney, Confirmation of Caudal Nee& Placement Using Nerve Stimulation , Anesthesiology , 1909;91 , 374 -378
12. Laxmaiah Manchikanti,Kim A. Cash,Vidyasagar Pampati,Carla D. McManus and Kim S. Damron, Evaluation of Fluoroscopically Guided Caudal Epidural Injections , Pain Physician, 2004;7:81-92,