ORIGINAL ARTICLE

Anatomical Variations of Sacral Hiatus in Dry Human Sacra

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ABSTRACT

Objective: To observe anatomical variations of sacral hiatus in dry human sacra and its significance in caudal epidural block.

Study Design: An observational study.

Place and Duration of Study: The study was conducted at Islamic International Medical College Rawalpindi from July 2011 to January 2012.

Materials and Methods: We studied 191 dry human sacra without discrimination of sex, geographical and ethnic group consideration. The bones were examined for various shapes of the sacral hiatus and level of apex and base of the sacral hiatus. Sacral cornua and median crest was also observed. The sacral hiatus were divided into six groups. (Group I-inverted U, group II- inverted V, group III= irregular, group IV- M shape, group VI-dumbbell shape). SPSS 17 was used for the statistical analysis of the data.

Results: Out of 191 bones, inverted U shaped 76 (39%) and V shaped 56 (29%) sacral hiatus were most common and irregular 29 (15%) sacral hiatus was least common. Sacral cornua were prominent bilaterally in 83 (46.5%) bones while flat cornua were seen in 16 (9%). The apex of hiatus was lying against 4th sacral vertebra in 129(73%) bones while base of was present against 5th sacral segment in 183(91%) of cases.

Conclusion: The sacral hiatus has variations in shape. Inverted U shaped and inverted V shaped hiatus are most common shapes in dry human sacra. Sacral cornua are a reliable landmark in Caudal Epidural Block (CEB).

Key words: *Sacrum, Caudal Epidural Block, Variations, Hiatus.*

Introduction

Sacrum is formed by the fusion of five sacral vertebrae in the adult. It is wedged between the two iliac bones forming the concave posterosuperior wall of the pelvic cavity.[1] On posterior surface, there are special markings which represent the fusions of various components of sacral vertebrae. The median sacral crest is formed by fusion of spinous processes.[2] The area between the median sacral crest and dorsal sacral foramina is formed by the fused laminae while laterally fused articular processes form intermediate sacral crest. Lateral to dorsal sacral foramina is a lateral sacral crest, which is formed by the fused transverse processes.[3] Inferiorly, incomplete fusion of laminae of 5th sacral vertebrae leads to formation of an opening on posterior surface in midline: sacral hiatus. This failure of fusion may extend up to the 2nd sacral vertebra.[4, 5, 6] The fifth inferior articular processes project caudally and flank the sacral hiatus as sacral cornua. The sacral canal contains the cauda equina including filum terminale and the spinal meninges.[7] The subarachnoid and subdural spaces usually cease near second sacral vertebrae while epidural space persists below the S2 level.[8] The sacral hiatus contains fifth sacral coccygeal nerve roots, filum terminale externa and fibro fatty tissue. It is used in caudal epidural block (CEB) to approach the sacral and coccygeal nerves. This block is often employed to relax the perineal musculature for painless childbirth as well as anal, perineal, urological, gynaecological and obstetric operations that do not involve the anterior abdominal wall.[9] The reliability, success and safety of caudal epidural block depend upon the ability to locate the hiatus and to define its anatomical variations. The key to success in any regional anesthesia is a sound and updated knowledge of anatomy of that region, Only the complete knowledge variations in sacral hiatus can reduce the failure rate [10,11] as 3 % failure in caudal epidural block has been attributed to agenesis of the sacral hiatus.[12] Various shapes of sacral hiatus have been reported in literature. As possible variations exist among different population, a study was designed to observe the anatomical variations in the human dry sacral bones.

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Materials and Methods

The study was conducted at Department of Anatomy, Islamic International Medical College Rawalpindi from July 2011 to January 2012. Dry human sacra were studied in medical colleges of

Rawalpindi and Peshawar (Khyber Medical College & Peshawar Medical College). We studied 201 dry human sacra without discrimination of sex, geographical and ethnic group consideration. All complete bones were included while 1 bone with hiatal agenesis and 9 bones with open dorsal wall were excluded.

Following parameters of each sacrum were studied:

1. Shape of the sacral hiatus
2. Level of Apex the sacral hiatus
3. Level of base of the sacral hiatus
4. Bilateral prominent (> 3mm in diameter) or flat sacral cornua

The possible shapes of sacral hiatus were divided into six groups. Each bone was observed separately for level of base and apex of sacral hiatus. Bones were grouped on the basis of their shapes.

Group I= Inverted U shape,
Group II=Inverted V shape,
Group III= Irregular shape,
Group IV= M shape,
Group V= Dumbbell shape

SPSS 17 was used for the statistical analysis of the data, while Microsoft Word 2007 and Microsoft Excel 2007 were used to generate graphs and tables.

Table I: The frequency distribution of the levels of apex and base in all shapes of sacral hiatus (n= 191)

Group I= Inverted U shape, Group II=Inverted V shape, Group III= Irregular shape, Group IV= M shape, Group V= Dumbbell shape

	Vertebral Level	Shapes of sacral hiatus				
		Group I	Group II	Group III	Group VI	Group V
		75 (39%)	56 (29%)	29 (15%)	15 (8%)	16 (9%)
Level of apex of sacral hiatus	S2 2 (1%)	1	0	0	0	1
	S3 46 (24%)	17	19	4	5	1
	S4 129 (73%)	55	35	25	10	14
	S5 4 (2%)	2	2	0	0	0
Level of base of sacral hiatus	S5 183 (96%)	72	53	28	14	16
	Coccyx 8(4%)	3	3	1	1	0
Flat sacral cornua	18 (9%)	3	5	6	-	4
Bilateral prominent cornua	89 (46.5%)	24	33	7	11	14
Prominent median crest	20 (10%)	5	6	5	-	4
Flat median crest	10 (5%)	2	4	3	1	-

Results

Out of 191 bones, inverted U shape 76(39%) and inverted V shape 56 (29%) sacral hiatus were most common. There were 29(15%) irregular, 16(9%) dumbbell shape and 15 (8%) M shaped sacral hiatus. The level of the apex was quite variable and extended between the middle of 2nd to the middle of 5th sacral segments. Out of 191, 139 (73%) sacra had the apex against the 4th sacral vertebra. Long sacral hiatus was observed with the apex against 2nd and 3rd sacral segments in 2(1%) and 46 (24%) specimens respectively. Small hiatus was also found in 4 (2%) bones with the apex against 5th sacral segment. Base of sacral hiatus was present between middle of 5th sacral segment to middle of 1st piece of coccyx. Out of 191 sacra, the base of the sacral hiatus was most commonly present against the 5th sacral segment 183(96%), while only 8(4%) had it base lying against the coccyx. Sacral cornua were prominent bilaterally in 89(46.5%) while 18(9%) bones had flat cornua. Median crest was prominent in only 20(10%) bones.

Discussion

Sacral hiatus is an important landmark for a successful caudal epidural block. [13] CEB The needle is passed through hiatus to reach the caudal spinal canal.[14] There is an increased awareness of adverse effects related to the technique and placement of the local anesthetic in the canal. In adults, anatomical variations in hiatus make it technically difficult to perform CEB and may be the cause of failure.[10,15,16] In the present study, sacral hiatus was absent in one bone only (0.5%), similar results are reported by Sekiguchi et al[17] 0.7% and Aggarwal A[18] 0.5%. Complete agenesis of dorsal wall was found in 4.5% of cases which does not match the findings of Sekiguchi et al[17] 1%, Nagar[19] 1.5% and Parashuram R[20] 2 %. Among the five possible shapes, inverted U (39%) and inverted V (29%) shape were the most common shapes. These results were similar to Nagar[19] 41.5% and 27% for inverted- U and V shape sacral hiatus. These two shapes normally provide enough room for introducing needle into sacral canal. The distribution of other shapes was different from other studies which may be due to racial difference.[18] In 9% bones dumbbell shaped hiatus was observed which is similar to Kumar V[21] 7.43% but differs from 2% in Parashuram R[20] study. In 8% bones,

outline of hiatus was M-shaped while Aggarwal A[18] observed this shape in 0.88% bones. The sacral hiatus was irregular in 15% bones which is similar to Parashuram R[20] 15.5% and Nagar[19] 14.1%. Apex of sacral hiatus lies usually at S4 level. A higher apex requires precaution while passing needle through sacral canal. In our study, the apex was lying against S4 in 73% bones which matches with results of Parashuram R[20] 72.2% although Aggarwal A[18] study reported 68.42%. In 24% bones, the apex was found at S3 level, similar results were reported by Parashuram R[20] 20% , but Nagar[19] and Kumar V[21] has reported 37% , 8.9% respectively. There were only 2% bones that had very small hiatus: apex lying against S5 but Parashuram R[20] has reported 6.7% sacra with small hiatus. In small hiatus there is a small space for needle insertion. Sacral hiatus till S2 was observed in 1% bones, which is closer to the study reported by Aggarwal A[18] 2.6% and Nagar[19] 3.4%. Base of sacral hiatus was seen at S5 vertebral level in 96% specimen but Aggarwal A[18] found it in 61% and Nagar[19] in 72.6%. The base of sacral hiatus was at coccyx in 4% bones, it did not match Aggarwal A[18] and Nagar [19] study who found it in 27% and 16% bones respectively. Sacral cornua are the most commonly used landmark to identify sacral hiatus before CEB. Sacral cornua are either palpable bony tubercles or flat. Prominent bony cornua (>3mm) can easily be palpated even when covered by skin and subcutaneous fat. In our study, sacral cornua were prominent in 46.5% bones and still higher ratio (55.26%) is reported by Aggarwal A[18] but Sekiguchi et al[17] reported 21%. Bilaterally flat cornua were found in 9 % bones in contrast to 21.05%, 50% reported by Aggarwal A[18] and Sekiguchi et al[17] respectively. Therefore sacral cornua are reliable landmarks in our population. Median crest may be an additional bony landmark for locating sacral hiatus. In our study, median crest was prominent in 10% bones while inconspicuous crest was found in 5% of sacra which is closer to 3.55 % observed by Aggarwal A.[18] Therefore we cannot trust median crest

Conclusion

The sacral hiatus has variations in shape. Inverted U shaped and inverted V shaped hiatus are most common shapes in dry human sacra. Sacral cornua are a reliable landmark in Caudal Epidural Block (CEB).

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