

ORIGINAL RESEARCH**Morphometrical study of dried human sacra in population of North India with its clinical relevance****¹Dr. Shipra Gupta, ²Dr. Vibhu Deep, ³Dr. Shashi Bhushan Pandey, ⁴Dr. Rajveer Singh Chourasia**¹Associate Professor, ³Assistant Professor, ⁴Professor & HOD, Dept. of Anatomy, Prasad Institute of Medical Sciences, Lucknow, Uttar Pradesh, India²Assistant Professor, Dept. of Anatomy, Rani Durgavati Medical College, Banda, Uttar Pradesh, India**Correspondence:**

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Email: rajveer.chourasia79@gmail.com**Abstract****Background:** Sacral hiatus is clinically is very important for caudal epidural anaesthesia in various surgical procedures done in obstetrics, orthopedics, urology etc. The reliability and success rate of caudal epidural anaesthesia depends on anatomical variations of sacral hiatus. Hence the present study is done to understand the anatomical variations of sacral hiatus.**Material and methods:** The present study was a cross-sectional study and was conducted on 110 dried human sacra collected from Department of Anatomy of M.L.N. Medical college, Allahabad, K.G.M.U., Lucknow, G.S.V.M Medical college, Kanpur and Prasad Institute of Medical Sciences, Lucknow. Digital vernier caliper with an accuracy of 0.01mm and digital camera were the main equipments to study the various parameters.**Results:** The sacrum consists of five segments in 110 (100%) sacra. Various shapes of sacral hiatus were observed which includes inverted U (41.8%), inverted V (32.2%), irregular (10.9%), dumb-bell (10%), bifid (1.8%) and deficient dorsal wall (2.7%). The apex of sacral hiatus was commonly found at the level of 4th sacral vertebra in 70% and the base of sacral hiatus at 5th sacral vertebral level in 93.6%. Mean length of sacral hiatus was 24.26mm. Mean antero-posterior depth of sacral hiatus at apex was 4.67mm and transverse diameter at base was 15.05mm.**Conclusion:** It was concluded that the sacral hiatus has anatomical variations and understanding of these variations will improve the success rate of caudal epidural block and will decrease its failure rate.**Introduction**Sacrum is a large triangular bone and is formed by fusion of five sacral vertebrae in the adult. Its blunted, caudal apex articulates with the coccyx and its superior, wide base with the fifth lumbar vertebra at the lumbosacral angle. The sacrum presents a base, an apex, pelvic, dorsal and lateral surfaces and a sacral canal. ⁽⁵⁾The opening 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 4th) sacral vertebra. It is located inferior to the 4th (or 3rd) fused sacral spines or lower end of median sacral crest. The sacral hiatus is identified by palpation of sacral cornua. Sacral cornua are felt at the upper end of the natal cleft 5cm above the tip of the coccyx.

The sacral hiatus contains fifth sacral nerve, coccygeal nerve roots, filum terminale externa and fibrofatty tissue. In recent state the sacral hiatus is covered by superior posterior sacrococcygeal ligament which is attached to the margins of the sacral hiatus and the deep posterior sacrococcygeal ligament attached to the floor of sacral hiatus.⁽⁶⁾

Clinical importance of sacral hiatus is that sometimes the anaesthetic agents are injected through the sacral hiatus in caudal epidural anaesthesia to act on the sacral and coccygeal nerves. This is often employed to relax the perineal musculature for painless childbirth.⁽²⁾

The reliability and success of caudal epidural anaesthesia depends upon anatomical variations of sacral hiatus as observed by various authors.^(4,7,10)

Keeping in view the importance of caudal epidural block, the present study was conducted to find out the anatomical variations of sacral hiatus in dried human sacra of North India.

Material and Method

The present study was a cross-sectional study and was conducted on 110 dried human sacra collected from Department of Anatomy of M.L.N. Medical college, Allahabad, K.G.M.U., Lucknow, G.S.V.M Medical college, Kanpur and Prasad Institute of Medical Sciences, Lucknow.

Following parameters were studied.

1. The shape of sacral hiatus was noted by naked eye appearance.
2. Level of apex of sacral hiatus was noted with respect to sacral vertebra.
3. Level of base of sacral hiatus was noted with respect to sacral vertebra.
4. The length of sacral hiatus was measured with the help of vernier caliper, from midpoint of base to apex.
5. Antero-posterior depth of sacral hiatus at the apex was measured with the help of vernier caliper.
6. Transverse width of sacral hiatus at the base was measured between the inner aspects of inferior limit of sacral cornua with the help of vernier caliper.

Damaged and deformed sacra were excluded from the study.

Data obtained was tabulated, analyzed and compared with previous studies done by various authors.

Observations and Results

Table No. 1- Shape of the Sacral Hiatus (n=110)

S. No.	Shape	No. of Specimen	Percentage (%)
1	Inverted U	46	41.8%
2	Inverted V	36	32.7%
3	Irregular	12	10.9%
4	Dumb-bell	11	10%
5	Bifid	2	1.8%
6	Deficient dorsal wall	3	2.7%

Various shapes were found in 110 dried human sacra. Among them most common shape of sacral hiatus was inverted U found in 46 sacra followed by inverted V in 36 sacra. Deficient dorsal wall was seen in 3 sacra and they were excluded from evaluation of further parameters because typical sacral hiatus was not present in them.

Fig. 1: Inverted U shaped sacral hiatus



Fig. 2: Inverted V shaped sacral hiatus



Fig. 3: Irregular shaped sacral hiatus



Fig. 4: Bifid shaped sacral hiatus**Fig. 5: Deficient dorsal wall of sacral hiatus****Table No. 2- Level of apex of Sacral Hiatus (n=107)**

S. No.	Level of apex	No. of Specimen	Percentage (%)
1	S3	29	27.1%
2	S4	77	72%
3	S5	1	0.9%

Table No. 3- Level of base of sacral hiatus (n=107)

S. No.	Level of base	No. of Specimen	Percentage (%)
1	S5	103	96.2%
2	S4	4	3.7%

Table No. 4- Length of sacral hiatus from apex to mid-point of base (n=107)

S. No.	Length of sacral hiatus (mm)	No. of Specimen	Percentage (%)
1	0-10	1	0.9%
2	10-20	42	39.3%
3	20-30	37	34.6%
4	30-40	22	20.6%
5	40-50	5	4.7%

Table No. 5- Antero-posterior depth of sacral hiatus at the level of apex (n=107)

S. No.	Antero-posterior Depth of sacral hiatus (mm)	No. of Specimen	Percentage (%)
1	0-3	7	6.5%
2	3-6	88	82.2%
3	6-9	12	11.2%

Table No. 6- Transverse width of sacral hiatus at the level of Base (n=107)

S. No.	Transverse width of sacral hiatus at base (mm)	No. of Specimen	Percentage (%)
1	0-5	0	0%
2	5-10	4	3.7%
3	10-15	51	47.7%
4	15-20	48	44.9%
5	20-25	4	3.7%

Discussion

Sacral hiatus is clinically very important because now-a-days this route is commonly used for giving caudal epidural block for painless delivery and in management of chronic back pain. Anatomical variations of sacral hiatus is directly related to the success and reliability of caudal epidural block.

In present study various shapes of sacral hiatus were observed. Most common shape was inverted U found in 46 sacra (41.8%) followed by inverted V in 36 sacra (32.7%). Irregular and bifid type of sacral hiatus were found in 12 sacra (10.9%) and 2 sacra (1.8%) respectively. Dumb-bell shaped sacra with irregular margins in middle of sacral hiatus was seen in 11 sacra (10%). Findings of present study were similar with the study conducted by Nagar SK.⁽³⁾ Whereas Vinod Kumar et al⁽¹⁰⁾ observed that most common shape of sacral hiatus was inverted V(46.53%).

Table 7: Comparison of shapes of sacral hiatus with previous studies

Shape of Sacral hiatus	Vinod Kumar ⁽¹⁰⁾ , 1992 (n=202)	Nagar SK ⁽³⁾ , 2004 (n=270)	Present Study (n=110)
Inverted U	60 (29.7%)	112(41.5%)	46(41.8%)
Inverted V	94(46.53%)	73(27%)	36(32.7%)
Irregular	-	38 (14.1%)	12(10.9%)
Dumb-bell	15(7.43%)	36(13.3%)	11(10%)
Bifid	-	4(1.5%)	2(1.8%)
Complete spina bifida	3(1.49%)	4(1.5%)	-
Deficient dorsal wall	2(0.99%)	4(1.5%)	3(2.7%)

In present study the apex of sacral hiatus was most commonly found at the level of 4th sacral vertebra in 77 sacra (72%). Similar results were observed by Vinod Kumar et al⁽¹⁰⁾, Sekiguchi M⁽⁴⁾ and Nagar SK⁽³⁾

The level of apex of sacral hiatus is clinically important because apex is nearer to lower end of dural sac. If the apex is present at 2nd or 3rd sacral vertebral level than there are more chances of puncture of dural sac.

Table 8: Comparison of level of apex of sacral hiatus with previous studies

Level of apex of sacral hiatus	Vinod Kumar ⁽¹⁰⁾ 1992 (n=202)	Sekiguchi ⁽⁴⁾ 2004 (n=92)	Nagar SK ⁽³⁾ 2004 (n=270)	Present Study (n=107)
S2	4.95%	4%	3.4%	-
S3	8.91%	15%	37.3%	29(27.1%)
S4	76.23%	65%	55.9%	77(72%)
S5	7.43%	15%	3.4%	1(0.9%)

In present study the base of sacral hiatus was most commonly found at the level of 5th sacral vertebra in 103 sacra (96.2%). Similar results were observed by Vinod Kumar et al⁽¹⁰⁾ and Nagar SK⁽³⁾

Table 9: Comparison of level of base of sacral hiatus with previous studies

Level of base of sacral hiatus	Vinod Kumar ⁽¹⁰⁾ 1992 (n=202)	Nagar SK ⁽³⁾ 2004 (n=270)	Present Study (n=107)
S5	83.17%	191 (72.6%)	103(96.2%)
S4	-	29(11.1%)	4(3.7%)
Coccyx	14.35%	43(16.3%)	-

In present study length of sacral hiatus varied from 7.53 to 46.08 mm with a mean length of 24.26 mm. Trotter et al⁽⁸⁾ have reported that length of sacral hiatus ranged from 0 to 60 mm with a mean length of 25.5mm. Trotter and Lanier⁽⁹⁾ reported mean length of sacral hiatus as 24.8 mm in male and 19.8 mm in female. Vinod Kumar et al⁽¹⁰⁾ also reported similar results, mean length of sacral hiatus as 20 mm in male and 18.9 mm in female.

Antero-posterior depth of sacral hiatus is important because it should be sufficiently large to admit a needle. In present study the antero-posterior depth of sacral hiatus ranged from 1.8 to 7.8 mm with a mean length of 4.67 mm. Similar results were observed by various authors. Vinod Kumar et al⁽¹⁰⁾ reported mean depth as 4.8mm and Nagar SK⁽³⁾ reported mean depth as 4.88mm.

In present study the transverse width of sacral hiatus at base ranged from 8.4 to 21.92 mm with a mean length of 15.05 mm. Similar results were observed by various authors. Trotter et al⁽⁸⁾ have reported that the width of sacral hiatus ranged from 7 to 26 mm with a mean of 17 mm. Vinod Kumar et al⁽¹⁰⁾ reported width as 5 to 20 mm (Mean 13 mm) in male and 8 to 18 mm (12.5 mm) in female.

Table 10: Comparison of mean sacral length, mean A-P diameter at apex and mean transverse width at base with previous studies

Previous Authors	Mean Length of sacral hiatus (mm)	Mean A-P diameter of sacral hiatus at apex (mm)	Mean transverse width of sacral hiatus at base (mm)
Trotter & Letterman ⁽⁸⁾ (1944)	25.5 (0-60)	5.3 (0-11)	17 (7-26)
Trotter & Lanier ⁽⁹⁾ (1945)	24.8 American M 19.8 American F	-	-

Vinod Kumar ⁽¹⁰⁾ (1992)	M- 20 (3-37) F- 18.9 (9-36)	4.8 (0-12)	M- 13 (5-20) F- 12.5 (8-18)
Nagar SK ⁽³⁾ (2004)	5-69	4.88(2-14)	3-19
Sekiguchi ⁽⁴⁾ (2004)	-	6.0±1.9	10.2±0.35
Aggarwal ⁽¹⁾ (2009)	4.30-38.60	1.90-10.40	11.95±2.78
Present Study	24.26±8.99 (7.53-46.08)	4.67±1.12 (1.8-7.8)	15.05±2.46 (8.4-21.92)

Conclusion

The knowledge of anatomical variations of sacral hiatus is very important during administration of caudal epidural anaesthesia. Understanding of these variations will increase the success rate and reliability of caudal epidural anaesthesia.

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