

A Study On Morphological Variation Of Sacral Hiatus Of Human Sacrum In Rajasthan

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Abstract

Introduction: The sacrum is a large, triangular fused five sacral vertebrae and forms the postero-superior wall of the bony pelvis. Caudal opening of sacral canal is sacral hiatus. Various shapes of sacral hiatus were observed which included inverted U (63.33%), inverted V (11.11%), irregular (13.33%), dumbbell (4.4%) and M shape (8.88%). The apex of sacral hiatus was commonly found at the level of 4th sacral vertebra in 58.88% while base was located at 5th sacral vertebra in 66.66% cases. These variations may be found during post mortem examination or during routine classes for undergraduate students during cadaveric dissection of human body and osteology. The knowledge of anatomical variations of sacral hiatus is significant for administration of caudal epidural anaesthesia to improve its success rate.

Material and Methods: Present study was carried out on 90 dry human sacrum of unknown age and gender from Department of Anatomy, S.M.S. Medical college, Jaipur and Govt. Medical College, Bharatpur, Rajasthan.

Morphological features shape of sacral hiatus, level of apex and base of sacral hiatus were noted.

Results: 90 dry human sacrum were studied. Most common shape of SH was inverted 'U' in 57 (63.33%) sacrum. The apex of sacral hiatus was commonly found

at the level of 4th sacral vertebra in 53 (58.88%) sacrum while base was located at 5th sacral vertebra in 60 (66.66%) sacrum.

Conclusion: Variation of sacral hiatus and its narrowing at the apex is very important for anaesthetists, orthopaedic surgeons and neurosurgeons while applying caudal epidural anaesthesia. Knowledge of variations of different parameters studied in the present study may help to improve the success of caudal epidural block.

Keywords: *Sacral hiatus, Anaesthesia, Analgesia, Caudal Epidural block and Sacral Canal.*

Introduction

The sacrum is a large, wedge-shaped, triangular bone which contains fused five sacral vertebrae and forms the postero-superior wall of the pelvic cavity.[1] It is located between the hip bones and forms the roof and postero-superior wall of the posterior half of the pelvic cavity. The base of the sacrum is formed by the superior surface of the S1 vertebra which articulates with fifth lumbar vertebra at lumbosacral angle and its blunted caudal apex articulates with coccyx.

The sacrum is often wider in proportion to length in the female than in the male, but the body of the S1 vertebra is usually larger in males. The pelvic surface of the sacrum is smooth, concave and has four transverse lines on this

surface indicate the fusion of the sacral vertebrae which are connected by hyaline cartilage and separated by intervertebral discs[1,2].

The inferior half of the sacrum is not weight bearing; therefore, its bulk is diminished from above downwards. The sacrum provides strength and stability to the pelvis and transmits the weight of the body to the pelvis and pelvic girdle, the bony ring formed by the hip bones and sacrum, to which the lower limbs are attached[3].

The dorsal surface of the sacrum is rough, convex, and marked by five prominent longitudinal ridges. The central ridge, the median sacral crest, represents the fused rudimentary spinous processes of the upper three or four sacral vertebra and S5 vertebra has no spinous process. The intermediate sacral crests are the fused articular processes and the lateral sacral crest are the tips of the transverse processes of the fused sacral vertebrae.

The clinically important features of the dorsal surface of the sacrum are the inverted U-shaped sacral hiatus and the sacral cornua. Below the fourth (or third) tubercle there is an arched sacral hiatus in the posterior wall of the sacral canal. This hiatus is produced by failure of fusion of the lamina of the fifth sacral vertebra, and as a result the posterior surface of the body of S5 vertebra is exposed on the dorsal surface of the sacrum. The sacral cornua, representing the inferior articular process of S5 vertebra, project inferiorly on each side of sacral hiatus and are a helpful guide to its location [5]. The lower opening of the sacral canal is called sacral hiatus. It transmits the 5th pair of sacral nerves, coccygeal nerves & filum terminale externa .

Numerous anatomical variations may be found during post mortem examination or during routine classes for undergraduate students during cadaveric dissection of human body and osteology . The knowledge of anatomical

variations of sacral hiatus is important for anaesthetists, orthopaedic surgeons and neurosurgeons during surgery. It is significant for administration of caudal epidural anaesthesia to improve its success rate.

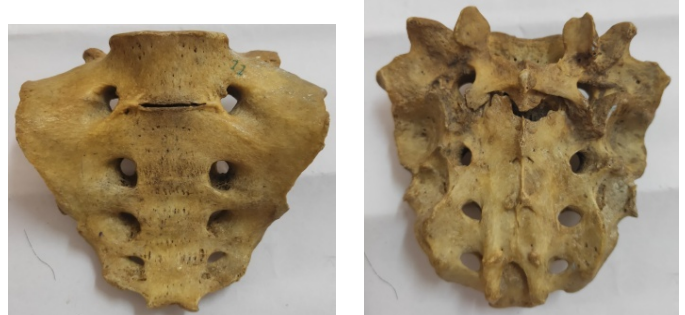


Figure 1: Normal Sacrum – Anterior & Posterior View

Materials and Methods

Present study was carried out on 90 dry human sacrum of unknown age and gender from Department of Anatomy, S.M.S. Medical college ,jaipur and Govt. Medical College, Bharatpur , Rajasthan . Damaged, mutilated & deformed sacra were excluded. Dry human sacra were studied for morphological variations of sacral hiatus.

Observation and Results

Various shapes of sacral hiatus were observed which included inverted U (63.33%), inverted V (11.11%), irregular (13.33%), dumbbell (4.4%) and M shape(8.88%). The apex of sacral hiatus was commonly found at the level of 4th sacral vertebra in 58.88% while base was located at 5th sacral vertebra in 66.66% cases. Various shapes of sacral hiatus was observed, most commonest was inverted 'U' shaped in 57(63.33%) sacrum; in 10(11.11%) sacrum Inverted 'V' shaped; irregular sacral hiatus was present in 11(13.33%) sacrum; M shaped in 8(8.88%) sacrum and in remaining 4 (4.44%) sacra dumbbell shaped sacral hiatus was present out of total 90 sacra (Table:1).

The level of the apex of sacral hiatus in relation to sacral vertebrae was observed, in 53(58.88%) sacra apex was

present at the level of S4, in 15(16.66%) sacra apex was present at the level of S5 and S3 and in remaining 7(7.77%) sacra apex was present at the level of S2(Table:2).

The level of base of sacral hiatus in relation to sacral or coccygeal vertebrae was observed, in 60(66.66%) sacra level of base was S5 vertebrae, in 8(8.88%) sacra level was S4 and in remaining 22 (24.44%) level was at coccyx (Table:3).

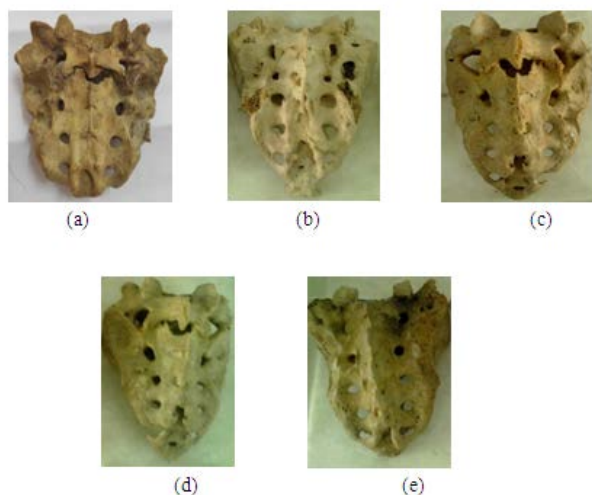


Figure 2: Different shapes of sacral hiatus- (a) Inverted U shaped; (b) Inverted V shaped; (c) Dumb bell shaped; (d) Bifid shaped; (e) Irregular shaped



Figure 3: Level of apex of sacral hiatus (arrow).



Figure 4: Level of Base of sacral hiatus (arrow).

Table no. 1: shapes of sacral hiatus

Shapes	Frequency(n)	Percentage (%)
Inverted ‘U’	57	63.33%
Inverted ‘V’	10	11.11%
Irregular	11	13.33%
Bifid shaped	8	4.44%
Dumbbell	4	8.88%
Total	90	100%

Table No. 2: Location of apex in relation to the level of sacral vertebrae

S.N.	Vertebral level	Location of Apex	
		Frequency (n)	Percentage
1	5th sacral vertebrae	15	16.66%
2	4th sacral vertebrae	53	58.88%
3	3rd sacral vertebrae	15	16.66%
4	2nd sacral vertebrae	7	7.77%

Table No. 3: Location of base in relation to the level of sacral vertebrae

S.N.	Vertebral level	Location of Base	
		Frequency (n)	Percentage
1	5th sacral vertebrae	60	66.66%
2	4th sacral vertebrae	8	8.88%
3	coccyx	22	24.44%

Discussion

The sacrum has three surfaces (Pelvic, dorsal and lateral) , a base and apex . The dorsal surface of the sacrum is convex and has median sacral crest. The sacral canal is a continuation of the spinal canal and runs throughout the greater part of the sacrum. The failure of the fusion of the lamina of the fifth sacral vertebra or sometimes fourth sacral vertebra resulting the sacral hiatus.

The present study was done on the shape of the sacral hiatus, the level of the apex and base of the sacral hiatus.

Shape of the sacral hiatus: In the present study there were six types of sacral hiatus like inverted “U”, inverted “V”, irregular, dumb bell and bifid types (fig 2a-2e)

Comparison is done in Variation in shape of sacral hiatus done by previous studies which is shown in Table :1

Inverted “U” shaped hiatus: In the present study, most common shape of sacral hiatus observed was inverted U (63.33%) which is almost equal to Dr.Qudusia sultana et al.(62.37 %), R.Sasikumar K (66.3 %),and Bhattacharya et al (65%).

Kumar et al. (1992) noted U-shaped in 29.70% , Singh et al(2016) in 22.39% , Shabana et al.in 29.4%, Mustafa et al. (2012) in 26% sacrum which is much lower from current study.

In a study by Vijisha and Baskaran (2013), the inverted U (35%) and Dona in 70.1% of specimens [11,12]. Nagar (2004) et al.,Clarista M.Q. et al., Seema et al, Shilpa Nilesh, et al., Rubisaikia et al., Malarvani et al. (2014) , Ukoha et al. (2014) , Mustafa et al. (2012) , Parashuram r. (2015) , Shewale et al (2013) reported u shaped hiatus in 41.5 % , 46.2%, 42.95%, 40.69 % , 56 % , 53.8 % , 35% , 48.2% , 50% , 40.69% respectively [4.5.6].

Inverted “V” shaped hiatus: R.Sasikumar K noted 11.3%, Nagar (2004) reported in 27 % , Dona saha in

14.53% and by Nadeem in 14% [13] of specimens. In the present study it was observed in 11.11% of specimens which is similar to these studies. Nagar S.K et al.(2004),Clarista M.Q. et al[23]., Seema et al, Shilpa Nilesh, et al., Dr.Qudusia sultana et al.,Shabana et al., Rubisaikia et al., Malarvani et al. (2014) , Ukoha et al. (2014) , Mustafa et al. (2012) , Singh et al(2016) , Parashuram r. (2015), Shewale et al (2013), Bhattacharya et al (2013)[5] reported 27 % , 24% , 27.51 % , 32.35% , 22.16 % , 22.47% , 29.8 % , 32% , 34.9% , 24% , 22.39% , 27.5% , 32.35% , 23% respectively. these studies shows little higher values .

Irregular shaped sacral hiatus: Irregular shaped hiatus was observed by Nagar in 14.1% [14] , Seema et al in 16.1%.Nadeem et al.(2014) in 16%. R.Sasikumar, K in 11.3%, Parashuram r. (2015) in15.5% and by Dona in 12.82% [9]of their specimens.In present study it was in 13.33% of sacra which is almost similar to the above studies.It is lower than other studies which is shown in Table 4.

Dumbbell shaped sacral hiatus: Dumbbell shaped hiatus was observed in 3.9% specimens by Dr. Qudusia sultana [8], 3.8% by R.Sasikumar. K , 2.24% byShabana et al. ,3% by Malarvani et al. (2014) ,4.8% by Ukoha et al. (2014) , 2% by Parashuram r. (2015), 5.89% By Shewale et al (2013). In the present study it is 4.44% which is near similar to other studies.

Nagar S.K et al.(2004) , Seema et al , Nadeem et al. (2014) , Mustafa et al. (2012) , Singh et al (2016) , Bhattacharya et al (2013) noted13.3%, 11.4% ,10% ,22%,17.91% respectively, which is higher than current study.[4.5.6]

5)Bifid shaped hiatus: In present study it was in 8.88 % which is similar to study by Singh et al (2016) , Shewale et al (2013),which is 8.96% and 9.31% respectively.

Nagar (2004), Seema et al, Dr.Qudusia sultana et al, Dona saha et al.[8,9], Rubisaikia et al., R.Sasikumar, K. Praveena kumara, et al, Malarvani et al. (2014) , Ukoha et al. (2014), Mustafa et al. (2012) , Parashuram r. (2015) recorded 1.5%, 2.01%, 1.54%, 1.71%, 0.9%, 1.3%, 2%, 4.8%, 0%, 2% respectively.

Table 4: Comparative study of shape of the sacral hiatus.

S.No.	Authors	Inverted “u”	Inverted “v”	Irregular	Bifid	Dumb-bell
1.	Nagar S.K et al.(2004)	41.5 %	27 %	14.1 %	1.5%	13.3%
2.	Clarista M.Q. et al.	46.2%	24%	-	-	-
3.	Seema et al	42.95%	27.51 %	16.1 %	2.01%	11.4%
4.	Shilpa Nilesh, et al.	40.69 %	32.35%	-	-	-
5.	Dr.Qudusia sultana et al.	62.37 %	22.16 %	8.76 %	1.54%	3.9%
6.	Shabana et al.	29.4 %	22.47%	-	-	2.24%
7.	Nadeem et al. (2014)	56 %	14 %	16 %	-	10%
8.	Dona saha et al.	70.09%	14.53 %	12.82 %	1.71%	0.85%
9.	Rubisaikia et al.	53.8 %	29.8 %	9.6 %	0.9%	5.7 %
10.	R.Sasikumar, K. Praveena kumara, et al	66.3 %	11.3%	11.3%	1.3%	3.8%
11.	Malarvani et al. (2014)	35%	32%	14%	2%	3%
12.	Ukoha et al. (2014)	48.2%	34.9%	4.8%	4.8%	4.8%
13.	Mustafa et al. (2012)	26%	24%	22%	0%	22%
14.	Singh et al(2016)	22.39%	22.39%	19.40%	8.96%	17.91%
15.	Parashuram r. (2015)	50%	27.5%	15.5%	2%	2%
16.	Shewale et al (2013)	40.69%	32.35%	.98%	9.31%	5.89%
17.	Bhattacharya et al (2013)	65%	23%	-	-	12%
18.	Present study	63.33%	11.11%	13.33%	8.88%	4.44%

Apex of the sacral hiatus: The apex of sacral hiatus is mostly present at the level of fourth sacral vertebra (Standing 2005). In the present study, the apex of sacral hiatus was seen at the level of fourth sacral vertebra in 58.88% of sacra which is nearly similar to that reported by Singh et al (2016)[4] in 62.3% , Sekiguchi et al. (2004) in 65% of sacra and Ukoha et al (2014) in 69.9%, Parashuram r. (2015) in 72.2%, Bhattacharya et al (2013) in 72% while Kumar et al. (1992) reported in 76.23% of sacra, Kumar et al. (2009) in 72%, Mustafa et al (2012) in Egypt in 70% of sacra . All previous studies

including the present study noted that the location of apex can vary from upper part of second sacral vertebra to lower part of fifth sacral vertebra.

Jeewanjotsekhon [22] observed the apex of the sacral hiatus was commonly present at the level of fourth sacral vertebra and base was at the level of fifth sacral vertebra. Dr. Qudusia sultana [8] noted the level of the apex of hiatus was at fourth sacral vertebra in 74.21% specimens. AshokK.R [19] observed apex of hiatus at the level of fourth sacral vertebra in 57.40%, at third sacral vertebra in 35.18%, at second sacral vertebra in 5.55% and at fifth

sacral vertebra in 1.85% of specimens. Other studies is mostly on fourth sacral vertebrae. shown in Table 5 shows that level of apex of sacral hiatus

Table 5: Comparative study of Apex and Base of the sacral hiatus.

S.N.	Authors	Apex of sacral hiatus				Base of the sacral hiatus.		
		S5	S4	S3	S2	S5	S4	Coccyx
1.	Nagar S.K et al.(2004)	3.4%	55.9%	37.3%	3.4%	72.6%	11.1%	16.3%
2.	Nadeem et al. (2014)	2%	34%	62%	2%	62%	24%	14%
3.	Malarvani et al. (2014)	2%	39%	42%	3%	54%	31%	1%
4.	Ukoha et al. (2014)	4.8%	69.9%	20.5%	2.4%	88%	2.4%	7.2%
5.	Mustafa et al. (2012)	17%	70%	13%	0%	91%	9%	0%
6.	Singh et al (2016)	14.75%	62.3%	21.31%	1.64%	81.97%	0%	18.03%
7.	Parashuram r. (2015)	6.7%	72.2%	20.6%	0.5%	93.3%	6.7%	0%
8.	Shewale et al (2013)	14.5%	60%	15%	4%	82%	2%	16%
9.	Bhattacharya et al (2013)	23%	72%	5%	-	-	-	-
10.	Present study	16.66%	58.88%	16.66%	7.77%	66.66%	8.88%	24.44%

Base of the sacral hiatus: In the present study the location of the base of sacral hiatus was present at the level of fifth sacral vertebra in 66.66% and at the level of fourth sacral vertebra in 8.88% of sacra which was similar to the previous study of Nagar S.K et al.(2004) in 72.6% and 11.1% ,Mustafa et al. (2012) in 91% and 9% ,Parashuram R. (2015)in 93.3% and 6.7 % respectively. Nadeem et al. (2014) reported in 62% and 24% respectively. Our study shows the base of sacral hiatus in 24.44% sacra on coccyx which is similar to study done by Nagar S.K et al.(2004) in16.3% ,Singh et al (2016) in 18.03%,Shewale et al (2013) in 16%.

Conclusion

The precise knowledge of normal and abnormal anatomy of the sacral hiatus are clinically important for the anesthetist, neurologist, radiologist and orthopedic surgeon in the clinical practice. Sacral cornua is an important bony land mark to locate the sacral hiatus during caudal epidural anesthesia

Variation in the anatomy of the sacral hiatus is one of the reason for the failure of caudal epidural block. The length of the sacral hiatus is too long is not favorable for caudal epidural anesthesia because it may lead to puncture of the dural sac.

The variation also leads a problem in transpedicular or lateral mass screw placement in the sacrum. The Clinician should be aware of the chances of agenesis of sacral hiatus or complete spina bifida while performing any procedure.

The knowledge of anatomical variations of sacral hiatus is very important while giving caudal epidural anesthesia to improve the success rate and reduces the incidence of complications.

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