



A Morphometric Study of Complete Agenesis of Dorsal Wall in Human Sacrum

KEYWORDS

Sacrum, Sacral hiatus, Sacral Canal, Caudal epidural anaesthesia.

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ABSTRACT Background : Sacrum is a large triangular bone, which is formed by the fusion of five sacral vertebrae. The ventral wall of sacral canal is formed by the fusion of body of sacral vertebra while dorsal wall is formed by fusion of laminae, spines & ossified ligamentum flava. There are numerous variations in dorsal wall of sacral canal. It may be open though out its entire length. To provide analgesia & anaesthesia the injections of medications are given into epidural space which is known as caudal epidural anaesthesia. The complete agenesis of dorsal wall of sacrum is among one of the contraindication of caudal epidural block.

Aim & Objective : To study the incidence of complete agenesis of dorsal wall of sacrum in Indian population & compare it with incidence among various races of the world.

Materials and methods : The present study has been carried out on 64 male & 52 Female (Total - 116) undamaged dry sacrum after calculating the sacral indices and sexing of sacra.

Results : Sacrum with complete agenesis of dorsal wall are found in 3 among 116 sacrum (2.58%), in which 2 (1.72%) belongs to male & 1 (0.86%) belongs to female. Thus, complete agenesis of dorsal wall of sacrum is more common in male as compared to female.

Conclusion : The dorsal wall of sacrum has different anatomical variations. Complete agenesis is among one of them, understanding about this variation may decrease the failure rate of caudal epidural anaesthesia & minimizes the complications during surgeries.

INTRODUCTION:

Sacrum is a large triangular bone, which is formed by the fusion of five sacral vertebrae. It forms the posterosuperior wall of the pelvic cavity.^[1] Four bones articulates with the sacrum i.e. its wide base articulates with 5th lumbar vertebra above, blunted caudal apex articulates with coccyx below and on both side it forms the sacroiliac joint with ilium of the innominate bones. The sacral vertebral foramina form the sacral canal, which is triangular in cross section. The ventral wall of sacral canal is formed by the fusion of body of sacral vertebra while dorsal wall is formed by fusion of laminae, spines & ossified ligamentum flava. This canal contains cauda equina, filum terminale & spinal meninges. The dura & arachnoid mater ends at the middle of sacrum and pia mater continues up to coccyx as filum terminale. There is an opening at the caudal end of sacral canal known as sacral hiatus, which is formed due to failure of fusion of laminae of the 5th (sometimes 4th) sacral vertebra. This hiatus is covered by the sacro coccygeal membrane, a subcutaneous fatty tissue & skin. There are numerous variations in dorsal wall of sacral canal. It may be open though out its entire length or may be low lying lamina of 1st sacral vertebra. In various clinical settings, to provide analgesia & anaesthesia the injections of medications are given into epidural space which is known as caudal epidural anaesthesia, which is first of all performed in 1900. In 1942, Edward & Hingson introduced continuous

caudal analgesia in obstetrics. This procedure stimulated the clinician & anatomist to make detailed study of sacral region. Apart from the obstetrics, caudal epidural anaesthesia is widely used in urology, orthopedics, proctology & general surgery. Hence a thorough knowledge of different anatomical features in the dorsal wall sacrum in male & female leads to reduction in the failures of administration of caudal analgesia.^[2] In unusually large hiatus, there is risk of puncturing of dural sac & making an intradural injection. The complete agenesis of the dorsal wall is one of the contraindications to caudal epidural block because of chances of puncturing the dura.^[3] Therefore, the knowledge about this variation is very helpful for anaesthetics & clinician in administration of caudal epidural block.

AIM & OBJECTIVE :

To study the incidence of complete agenesis of dorsal wall of sacrum in Indian population & compare it with incidence among various races of the world.

MATERIALS AND METHODS:

The present study has been carried out on 116 undamaged dry sacrum, which are available in the Department of Anatomy & Department of Forensic Medicine & Toxicology of Indira Gandhi Institute of Medical Sciences (Patna, Bihar, India), Lord Buddha Koshi Medical College (Saharsa, Bihar, India), Patna Medical College (Patna, Bihar, India) &

Nalanda Medical College (Patna, Bihar, India) after obtaining consents and permission for the study from heads of the department. These 116 sacrum are segregated into 64 male & 52 female sacrum after calculating the sacral index.

Sacral Index = Maximum breadth X 100 / Maximum Height.

The distance between two lateral most point on the ala of the sacrum is measured as maximum breadth of the sacrum & the distance in between sacral promontory and the corresponding lowest point in mid sagittal plane on the anterior margin of the sacrum is taken as maximum height of sacrum by a dial caliper. The Sacrum with sacral index < 105 are classified as male sacrum while that with > 115 are classified as female sacrum. Each sacrum is examined for the complete agenesis of the dorsal wall. Representative photographs of different sacrum having complete agenesis of the dorsal wall are taken using a digital camera (HTC desire mobile phone 13 Megapixels).

RESULTS:

Sacrum with complete agenesis of dorsal wall are found in 3 among 116 sacrum (2.58%), in which 2 (1.72%) belongs to male & 1 (0.86%) belongs to female. Thus, complete agenesis of dorsal wall of sacrum is more common in male as compared to female. [Table-1, Figure-1 & 2]

Table 1: Incidence of Complete agenesis of dorsal wall of sacrum.

	Incidence of Complete agenesis of dorsal wall
Male	2 (1.72%)
Female	1 (0.86%)
Total	3 (2.58%)

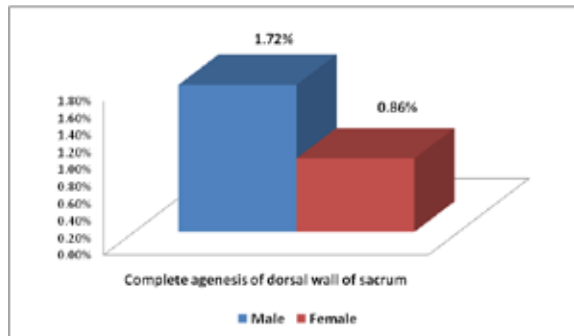


Figure 2: Comparative Incidence of Complete agenesis of dorsal wall of sacrum in male & female.

DISCUSSION:

The incidence of complete agenesis of dorsal wall in sacrum is 2.58% in our study. In different literature, we found incidence of complete agenesis of dorsal wall in sacrum varies from 0.98% to 4.3%. Nagendrappa R B et al^[4] found 3% incidence of complete spina bifida which is very near to our finding (2.58%). They also report the level of apex of sacral hiatus that varies from upper part of S2 to lower part of S5, in which most common position was at the level of S4. Nagar SK^[2] studied 270 sacrum and reported 1.5% scapula with complete agenesis of dorsal wall. He found inverted U shaped sacral hiatus in 41.5% sacrum, inverted V shaped in 27%, irregular in 14.1%, dumbbell shaped in 13.3% & bifid sacral hiatus in 1.5% cases. He also explained that apex of sacral hiatus was most commonly found at the level of 4th sacral vertebra. Kiran V P et al^[5] also reported 2% incidence of complete agenesis of dorsal wall. Shewale S N et al^[6] studied 204 sacrum

and found 0.98% complete spina bifida. They also found 40.69% sacrum with inverted U shape, 32.35% with inverted V shape, 9.31% with irregular, 5.89% with dumb-bell shape & 0.98% cases without sacral hiatus. They also explained that apex of sacral hiatus was most commonly found at the level of 4th sacral vertebra. Ukoha UU et al^[7] studied 83 Nigerian sacrum and found 1.3% complete spina bifida. They also found 48.2% sacrum with inverted U shape, 34.9% with inverted V shape, 4.8% with irregular, 4.8% with dumb-bell shape, 1.2% cases without sacral hiatus & 4.8% with bifid sacral hiatus. They also explained that apex of sacral hiatus was most commonly found at the level of 4th sacral vertebra. While, on another 54 Nigerian sacrum Osunwoke E.A. et al^[8] studied and found 24.1% sacrum with inverted U shape, 33.1% with inverted V shape, 13% with irregular, 9.3% with dumb-bell shape & 5.6% with bifid sacral hiatus. They also found that apex of sacral hiatus was most commonly found at the level of 4th sacral vertebra. Ali S et al^[9] found 1.6% complete spina bifida after study of 120 dry sacrum. They reported 45% sacrum with inverted U shape, 31% with inverted V shape, 17% with irregular, 4.2% with dumb-bell shape & 1.6% with bifid sacral hiatus. They explained the mean AP depth of sacral canal at the level of apex of sacral hiatus was 4.8mm & the mean length of sacral hiatus was 18.98 mm & the mean transverse width of sacral hiatus at the level of base was 11.41 mm. Sema et al^[10] observed 5 sacrum (3.14%) with complete agenesis of dorsal wall among 159 sacrum while we found 2.58% incidence of complete agenesis of dorsal wall. They described 42.95% sacrum with inverted U shape, 27.51% with inverted V shape, 16.1% with irregular, 13.41% with dumb-bell shape & 2.01% with bifid sacral hiatus in their study. They also found that apex of sacral hiatus was most commonly found at the level of 4th sacral vertebra i.e. in 56.36%. The mean length of sacral hiatus was 22.69 mm. The mean AP diameter of sacral canal at the apex of sacral hiatus was reported 6.49 mm. Swathi PC^[11] & Vanitha et al^[12] reported a single case of complete absence of dorsal wall of sacrum. Mishra M et al^[13] reported 4 cases (4.3%) in their study of 93 sacrum. They also found 50.53% sacrum with inverted U shape, 26.9% with inverted V shape, 11.8% with irregular, 5.4% with dumb-bell shape sacral hiatus in their study. They also reported 1% sacrum with absent sacral hiatus. They observed that apex of sacral hiatus was most commonly found at the level of 4th sacral vertebra. Malarvani T et al^[14] observed 3 sacrum (3%) with complete absence of dorsal wall among 100 sacrum while we found 2.58% incidence of complete agenesis of dorsal wall. They described 35% sacrum with inverted U shape, 32% with inverted V shape, 14% with irregular, 3% with dumb-bell shape & 2% with bifid sacral hiatus in their study. They also found that apex of sacral hiatus was most commonly found at the level of 3rd sacral vertebra. The length of the sacral hiatus varied between 12mm to 37mm. Detail knowledge of shape, position and the morphology of sacral canal are important for caudal epidural anaesthesia. Surgery around the sacrum requires understanding of the underlying anatomy and various morphometric parameters of sacrum.

Table 1: Comparison of incidence of complete dorsal wall agenesis by different authors.

Sr. No.	Author (Year of Study)	No. of Specimen Studied	Incidence of complete dorsal wall agenesis (%)
1.	Kumar V et al ^[15] (1992)	222	1.49%

2.	Nagar S K ^[2] (2004)	270	1.5%
3.	Senougluet et al ^[16] (2005)	96	2.08%
4.	Kiran V P et al ^[5] (2011)	50	2%
5.	Shewale S N et al ^[6] (2013)	204	0.98%
6.	Ukoha UU et al ^[7] (2013)	83	1.2%
7.	Ali S et al ^[9] (2013)	120	1.6%
8.	Sema et al ^[10] (2013)	159	3.14%
9.	Swathi PC ^[11] (2013)	Single Case Report	
10.	Nagendrappa RB et al ^[4] (2014)	100	3%
11.	Vanitha et al ^[12] (2014)	Single Case Report	
12.	Mishra M et al ^[13] (2014)	93	4.3%
13.	Malarvani T ^[14] (2015)	100	3%
14.	In Present study	116	2.58%

CONCLUSION:

The dorsal wall of sacrum has different anatomical variations. Complete agenesis is among one of them, understanding about this variation may decrease the failure rate of caudal epidural anaesthesia & minimizes the complications during surgeries.

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anda Medical College (Patna, Bihar, India) for granting the permission to carry out the study in their department.



Figure 1: Showing complete dorsal wall agenesis

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