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Complete Dorsal Wall Agenesis in the Human Sacrum and its Importance in Caudal Epidural Anaesthesia

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ABSTRACT:

Background: The sacrum, an enormous triangular bone, is formed when the five sacral vertebrae fuse together. While the dorsal wall of the sacral canal is generated by the fusing of the laminae, spines, and ossified ligamentum flava, the ventral wall is created by the fusion of the sacral vertebra's body. Numerous variations can be found in the sacral canal's dorsal wall. It might be entirely open all the way down. By injecting medications into the spinal canal, caudal epidural anaesthesia provides both analgesia and anaesthesia. One of the contraindications of caudal epidural block is the full agenesis of the sacral dorsal wall.

Aim & Objective: The objectives of the present study were to document the dorsal wall agenesis of sacrum among the sacra which belong to the North Indian population and compare the findings with various races of the world.

Materials and methods: The present study has been carried out on 164 male & 112 Female (Total - 276 sacrum) 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 276 sacrum (1.08%), in which 2 (0.72%) belongs to male & 1 (0.36%) belongs to female. So, compared to females, males are more likely to have a complete agenesis of the dorsal wall of the sacrum.

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Conclusion: It's a rare variation, and therefore knowledge about it may be beneficial for anthropologists, radiologists, orthopaedicians surgeons, and neurosurgeons, as well as anaesthetics during caudal epidural anaesthesia. Understanding these variances could increase the success rate of the caudal epidural block.

KEY WORDS: Sacrum, Sacral hiatus, Sacral Canal, Caudal epidural anaesthesia, Variations.

INTRODUCTION:

The five sacral vertebrae that make up the sacrum fuse together to create the huge triangular bone known as the sacrum. It constitutes the posterior wall of the pelvic cavity [1]. It creates the sacroiliac joint on both sides with the ilium of the innominate bones by articulating with the fifth lumbar vertebra above, the coccyx below, and the broad base and truncated caudal apex of the vertebra. These four bones connect to the sacrum at their points of articulation. The sacral vertebral foramina together form the triangular shaped sacral canal. The ventral wall of the sacral canal is formed by the bodies of the sacral vertebrae, and the dorsal wall is created by the ossification of the ligamentum flava, laminae, and spines. This canal is the home of the spinal meninges, cauda equina, and filum terminale. The dura and arachnoid mater are both terminated in the sacral centre. When the laminae of the fifth sacral vertebra (or occasionally the fourth) fail to fuse together, a sacral hiatus, or opening at the caudal end of the sacral canal results. This opening is covered by the sacrococcygeal membrane, subcutaneous fatty tissue, and the skin. Numerous variations can be found in the sacral canal's dorsal wall. Depending on its location, the lamina of the first sacral vertebra may be low-lying or open all the way around. First used in 1900, caudal epidural anaesthesia is a clinical technique that produces analgesia and anaesthesia by injecting drugs into the epidural space. It is utilised in a number of situations. For obstetrics, Edward initially employed continuous caudal analgesia in 1942. This procedure motivated clinicians and anatomists to thoroughly investigate the 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 anesthetics & clinician in administration of caudal epidural block.

AIM & OBJECTIVE:

To research the prevalence of full agenesis of the dorsal wall of the sacrum in the Bihari population and compare it to the prevalence of the condition in other global racial groups.

MATERIALS AND METHODS:

The present study was carried out on 276 undamaged dry sacra, which was obtained from the bone bank of Department of Anatomy and Forensic Medicine & Toxicology, Indira Gandhi

Institute of Medical Sciences, Patna, Bihar and also from different medical colleges of Bihar. We included only those sacra in the study which were fully ossified, dried, macerated and thoroughly cleaned and were complete in all respects in order to give correct observation. We excluded sacra having any gross deformity or pathology.
After determining the sacral index, these 276 sacra are divided into 164 male and 112 female sacra.
Sacral Index = Maximum breadth X 100 / Maximum Height.

By using a dial calliper, the distance between two lateral most points on the ala of the sacrum are measured as the maximum breadth of the sacrum, and the distance between the sacral promontory and the corresponding lowest point in the mid sagittal plane on the anterior margin of the sacrum is measured as the maximum height of the sacrum. Sacrum with sacral indexes less than 105 are classified as male sacrum, while those with sacral indexes greater than 115 are classified as female sacrum. Each sacrum is examined for complete dorsal wall agenesis. Using a digital camera, representative photographs of different sacrum with complete dorsal wall agenesis are taken.

RESULTS:

Sacrum with complete agenesis of dorsal wall is found in 3 among 276 sacrum (1.08%), in which 2 (0.72%) belongs to male & 1 (0.36%) belongs to female. So, compared to females, males are more likely to have a complete agenesis of the dorsal wall of the sacrum [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 (0.72%)
Female	1 (0.36%)
Total	3 (1.08%)

Figure 1: Showing complete dorsal wall agenesis

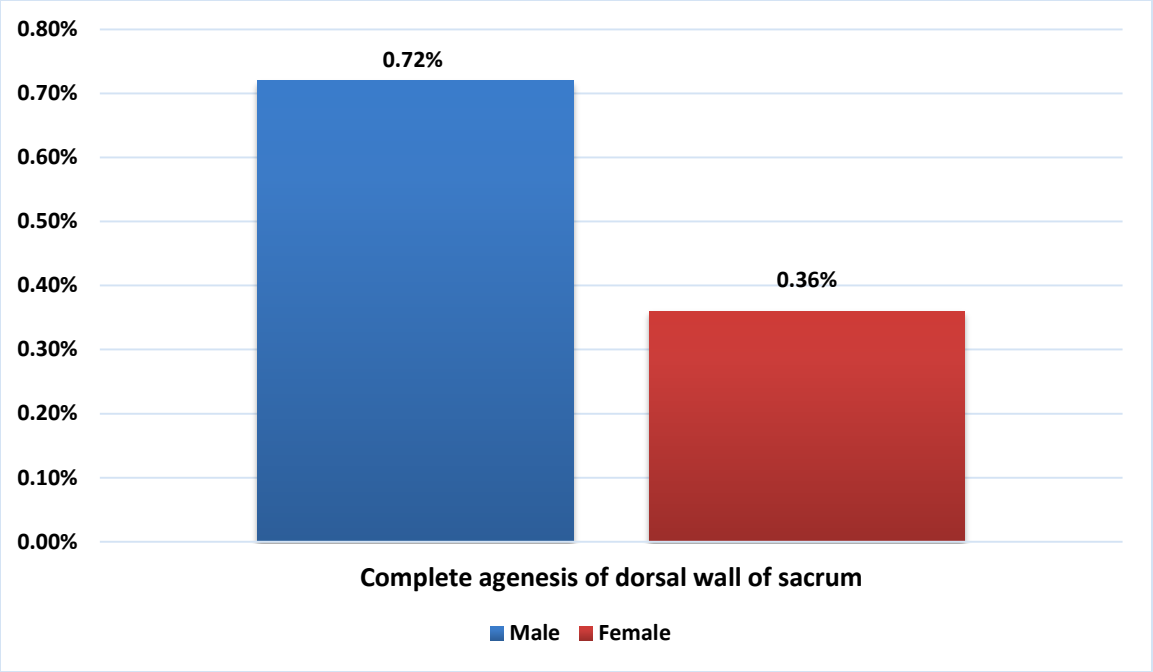

Figure 2: Figure showing comparison between incidence of complete agenesis of dorsal wall of the sacrum in male and female.

DISCUSSION:

In our study, the incidence of total dorsal wall agenesis in the sacrum was 1.08 percent. We discovered that the incidence of whole sacral dorsal wall agenesis ranges from 0.98 percent to 4.3 percent in various sources. Complete spina bifida incidence was determined to be 0.98 percent by Shewale S. N. et al. [4], which is extremely similar to our finding (1.08 percent). Additionally, they note that the level of the sacral hiatus' apex varies from the upper portion of the S2 to the lower part of the S5, with the level of the S4 being the most typical position. In a study of 270 sacra, Nagar SK [2] found that 1.5% of the sacra had a complete agenesis of the dorsal wall. In 41.5 percent of the sacrum, he discovered an inverted U-shaped sacral hiatus, inverted V-shaped in 27 percent, irregular in 14.1 percent, and dumbbell-shaped Spina bifida was discovered in 0.98 percent of the 204 sacra investigated by Shewale S. N. et al. [4] Additionally, he discovered that 40.69 percent of sacra had an inverted U form, 32.35 percent had an inverted V shape, 9.31 percent had an irregular shape, 5.89 percent had a dumbbell shape, and 0.98 percent of instances lacked a sacral hiatus. The fourth sacral vertebra is the level at which the sacral hiatus's apex is most frequently detected, he added. One percent complete spina bifida was discovered in the 83 Nigerian sacra that Ukoha UU et al [5] investigated. He also discovered that 48.2% of sacra had an inverted U form, 34.9 percent had an inverted V shape, 4.8 percent had an irregular shape or a dumb-bell shape, 1.2 percent of instances had no sacral hiatus, and 4.8 percent had a bifid sacral hiatus. The fourth sacral vertebra is the level at which the sacral hiatus's apex is most frequently detected, he added. While, on another 54 Nigerian sacrum Osunwoke E.A. et al [6] 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. Although, on Ali S et al [7] 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 [8] 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 average sacral hiatus measured 22.69 mm. The mean AP diameter of sacral canal at the apex of sacral hiatus was reported 6.49 mm. Swathi PC [9] & Vanitha et al [10] reported a single case of complete absence of dorsal wall of sacrum. Mishra M et al [11] 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 [12] observed 3 sacrum (3%) with complete absence of dorsal wall among 100 sacra 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. Saha D et al [13] (2016) observed 4 sacrum (1.33%) with complete absence of dorsal wall among 300. Additionally, the percentages of the elongated sacral hiatus were calculated, with 8 (2.73%) sacra showing a sacral hiatus length greater than 20 mm. Maximum sacral hiatal length of 51.7 mm was noted. They reported two types of elongated sacral hiatus i.e. inverted U and inverted V shaped. Partial agenesis of dorsal wall in sacra were reported in 3 % i.e. 9 bones. Complete dorsal agenesis was seen in 1.33 % sacra. Two (0.67%) bones with absent sacral hiatus were seen. while we found 1.08% incidence of complete agenesis of dorsal wall. Out of eighty six sacra, two bones (2.33%) were found with complete absence of dorsal wall of sacral canal by Banerjee A et al [14] (2018). In present study, incidence of complete agenesis of dorsal wall of sacrum was 1.08% which comes under the range of incidence reported by previous authors. Agenesis of dorsal wall of sacrum occurs due to failure of the fusion of sacral lamina to form median sacral crest 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 [17] (2011)	50	2%
5.	Shewale S N et al [4] (2013)	204	0.98%
6.	Ukoha UU et al [5] (2013)	83	1.2%
7.	Ali S et al [7] (2013)	120	1.6%
8.	Sema et al [8] (2013)	159	3.14%
9.	Swathi PC [9] (2013)	Single Case Report	
10.	Nagendrappa RB et al [18] (2014)	100	3%
11.	Vanitha et al [10] (2014)	Single Case Report	
12.	Mishra M et al [11] (2014)	93	4.3%
13.	Malarvani T [12] (2015)	100	3%
14	Saha D [13]	300	1.3%

	(2016)		
15.	Banerjee A [14] (2018)	86	2.33%
16.	Gaikwad M [19] (2019)	Single Case Report	
17.	Jha N K [20] (2021)	Single Case Report	
18.	In Present study (2022)	276	1.08%

CONCLUSION:

Variation of the dorsal wall of sacrum is a rare variation, and therefore knowledge about it may be beneficial for anthropologists, radiologists, orthopaedicians surgeons, and neurosurgeons, as well as anaesthetics during caudal epidural anaesthesia. Understanding these variances could increase the success rate of the caudal epidural block.

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