

Dorsal sacral agenesis: A study on dry sacrum bones

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Abstract

Introduction: Sacral hiatus is the route for caudal epidural block. Dorsal agenesis of sacrum is a known cause for failure of caudal epidural anaesthesia.

Material and Methods: 300 dry sacral bones were studied for complete dorsal agenesis, partial dorsal agenesis, elongated sacral hiatus and absent hiatus.

Observations and Results: Complete dorsal agenesis was noted in 1.3% bones, elongated sacral hiatus in 3% sacrum and 0.67% bones showed absent sacral hiatus.

Conclusion: Variations in the dorsal sacral wall can lead to difficulty in administering caudal blocks. Knowledge of incidence of dorsal agenesis, elongated hiatus and absent hiatus will help anaesthetists to plan for a safer approach.

Keywords: Spina bifida, dorsal sacral agenesis, sacral hiatus, caudal epidural block, elongated sacral hiatus and absent sacral hiatus.

Introduction

Sacrum is a triangular shaped irregular bone formed by fusion of five sacral vertebrae. Sacrum is also called 'Hieron osteon' meaning the holy or sacred bone.¹ The dorsal surface of sacrum demonstrates a lateral sacral crest, intermediate sacral crest and median sacral crest formed by the fusion of transverse processes, articular process and spinous processes of the sacral vertebrae respectively. The lamina of the fifth and sometimes the fourth sacral vertebra don't fuse to form the spinous process. This is called the 'Sacral hiatus'. The structures passing through the sacral canal are cauda equina, sacral spinal nerve roots, filum terminale externa, fibro fatty tissue, epidural venous plexus and spinal meninges.²

The normal length of sacral hiatus is around 10 to 20 mm. When the hiatus length is more than 40 mm then it is called an elongated sacral hiatus. Dorsal agenesis of sacrum is one of the variations seen in sacrum. Here the median sacrum crest show partial or complete agenesis. Caudal epidural anaesthesia is indicated in pediatric surgeries and to reduce labour pains. Caudal epidural anaesthesia is administered through the sacral hiatus. In cases of dorsal agenesis of sacrum it is difficult to locate the hiatus. Partial blocks and complete failure of anaesthesia is seen in such patients. Other variations like absent sacral hiatus and elongated sacral hiatus also cause a problem in administering caudal epidural blocks.³

Study of dorsal agenesis of sacrum has been done in various countries like America by Trotter,⁴ in Turkey by Senoglu et al⁵ and in Africa by Nijihia and Awori⁶. In India a study in Gujarat was done by Nagar⁷ and in

West Bengal by Saha and Bhadra.⁸ The present study was done to find the incidence of dorsal agenesis of sacrum in Maharashtrian population and compare with studies done in other regions to look for any regional or racial variations.

Materials and Methods

This study was carried out in department of Anatomy of Dr. D. Y. Patil Medical College, Pimpri, Pune. 300 dry sacral bones from various Medical and Dental colleges of Maharashtra state were used for this study. Broken bones and sacrum with lumbarisation and lumbar vertebra with sacralisation were not considered. Sacrum was observed for elongated sacral hiatus, partial dorsal agenesis, complete dorsal agenesis and absent sacral hiatus. Vernier caliper was used to measure length of the sacral hiatus.

Observations and Results

Variations of dorsal wall of sacrum were tabulated and percentages were calculated. Elongated sacral hiatus i.e. length more than 20 mm was seen in 8 (2.73%) bones. Maximum sacral hiatal length of 51.7 mm was noted. Elongated sacral hiatus were of two types i.e. inverted U and inverted V shaped (Fig. 1 and 2). 9 (3%) bones showed partial dorsal agenesis of sacrum (Fig. 3 & 4). Complete dorsal agenesis (Fig. 5) was seen in 1.33 % sacra. Two (0.67%) bones with absent sacral hiatus were seen. (Fig. 6)

Table 1: Variations of dorsal wall of sacrum

| Features of dorsal wall of sacrum | Number of bones | Percentage (%) |
|-----------------------------------|-----------------|----------------|
| Partial Dorsal agenesis | 9 | 3 |
| Complete dorsal agenesis | 4 | 1.33 |
| Elongated sacral hiatus | 8 | 2.73 |
| Absent sacral hiatus | 2 | 0.67 |

**Fig. 1: Elongated inverted U shaped sacral hiatus****Fig. 2: Elongated inverted V shaped sacral hiatus****Fig. 3: Partial dorsal agenesis of sacrum****Fig. 4: Partial dorsal agenesis of sacrum****Fig. 5: Complete dorsal agenesis of sacrum****Fig. 6: Absent sacral hiatus**

Discussion

Dorsal agenesis is due to failure of fusion of the lamina of the sacral vertebrae to form the median sacral crest. Moore⁹ reason this condition to the faulty induction of vertebra formation by the underlying notochord during embryological development.

Spina bifida is an inclusive term for formative defects in neurulation and succeeding vertebral formation. This presents various neural tube defects like craniorachischis (non fusion of neural tube and non formation of vertebral arch), anencephaly (non fusion of ventral part of neural tube with no occipital development) and myelocele (non fusion of posterior part of neural tube and failure of vertebral arch development).¹⁰

Variations in length of sacral hiatus and dorsal wall of sacrum have been reported by various studies. Arora et al¹¹ in a study of sacrum in north Indian population observed a relatively higher incidence (16.85%) of elongated sacral hiatus. Other studies by Nagar⁷ in Gujarat and Nagendrappa and Jayanthi¹² in Karnataka reported similar findings of 4.9% and 4.1% respectively. Our study in Maharashtrian population observed a lower incidence of 2.73%.

Saha and Bhadra⁸ mentioned complete dorsal agenesis of sacrum as a cause for persistent lower back ache. In a study of 125 sacra in West Bengal population they found an incidence of complete dorsal agenesis as 1.6% which is similar to our study (1.3%). Knowledge

of such variations in dorsal wall of sacrum will help radiologists and spine surgeons to prevent wrong diagnosis and complications during surgery.

Absent sacral hiatus is a very rarely found variation. Administering caudal epidural block will be

impossible in such cases. Njihia and Awori⁶ and Nagendrappa and Jayanthi¹² found a higher incidence of 1.2% and 1% respectively. Nagar⁷ reported 0.7% incidence of absent hiatus, which is similar to 0.67 % incidence found in our study.

Table 2: Comparison of present study with previous studies. (Numbers are showing percentage)

| Features of dorsal wall of sacrum | Nagar ⁷ | Arora ¹¹ et al | Nagendrappa and Jayanthi ¹² | Present study |
|-----------------------------------|--------------------|---------------------------|--|---------------|
| Dorsal agenesis | 4.38 | 4.48 | | 3 |
| Complete dorsal agenesis | 1.5 | 2.24 | 3 | 1.33 |
| Elongated sacral hiatus | 4.9 | 16.85 | 4.1 | 2.73 |
| Absent sacral hiatus | 0.7 | | 1 | 0.67 |

Surface landmarks like sacral cornu are palpated to locate the sacral hiatus. Surjit and Shipra¹³ have discussed in a case report the structural and radiological aspects of spina bifida with a higher sacral hiatus. In caudal epidural Block, there was 74% success rate under fluoroscopy guidance. This success rate increased to nearly 100% in ultrasonography guided needle placement. Presence of spina bifida could lead to damage to neural structures which are otherwise covered by sacral canal. The exact topographical anatomy of sacrum is important for caudal epidural block. Presence of anatomical variations may contribute to higher failure rate. 7% failures of caudal epidural block have been attributed to elongated sacral hiatus, hiatal agenesis or complete agenesis.

Senuglu et al⁵ et al opine that developmental defects of the spine must be considered for the sake of patient safety. In a case report of completely bifid sacrum, authors stated that presence of anatomical variations may contribute to a high failure rate of caudal epidural block (7%) transpedicular and lateral screw placement. Total spina bifida and detection of duramater just beneath the hiatus have been observed in 1% of cases. Presence of spina bifida increases the chances of damage to the sacral nerves during internal screw fixation.

Caudal epidural anaesthesia is commonly administered in patients of radiculopathy and lower back pain. Doo et al¹⁴ stated that dorsal sacral agenesis can lead to unforeseen complications like intravenous injections and dural puncture. So ultrasound or fluoroscopy guidance while administering caudal block is indicated for better patient outcome.

Caudal epidural blocks are commonly used in urology, proctology, general surgery and obstetrics and gynecology. Knowledge about various shapes of sacral hiatus and various defects of dorsal wall of sacrum is important for anesthetist administering caudal epidural blocks. Dorsal agenesis of sacrum is also one of the differential diagnosis for lower back ache.¹⁵

Saberski et al¹⁶ in a case report of a patient for a therapeutic steroid epidural injection for persistent radiculopathy, observed that the epidural space can be accessed safely with flexible fiberoptic catheter via the sacral hiatus with subsequent three dimensional color visualization of the contents. They opine that the straight entry allowed for easier maneuvering of the fiberoptic scope and laid the foundation for further fiberoptic guided procedures. Any variation in the dorsal wall of sacrum will lead to complications in entry of fiberoptic catheter.

Daftary and Jagtap¹⁷ in a study of 43 high risk infants which included preterm seriously ill infants, noted that caudal epidural can be used as the sole anaesthetic. Caudal epidural block was performed on these infants for ano-rectal, abdominal and inguinal surgeries. It rules out the need for general anaesthesia and endotracheal intubation, but requires an experienced anesthesiologist and surgeon with knowledge about variations of sacral hiatus and dorsal wall of sacrum.

Patil¹⁸ et al reported 2.91% incidence of complete dorsal agenesis of sacrum. The superolateral sacral crests are superimposed on the posterior superior iliac spines on surface of skin. Authors strongly advocate the use of an equilateral triangle formed by joining the right and left superolateral sacral crest and the apex of the sacral hiatus as a surface landmark for locating the hiatus for giving caudal epidural anaesthesia. Locating this equilateral triangle is not possible in cases of dorsal agenesis of sacrum. So fluoroscopy is considered as a gold standard investigation while administering a caudal epidural block.

Conclusion

Various anomalies of dorsal wall of sacrum were seen in Maharashtrian population. Knowledge of these variations will be of help to the Anaesthetists. We conclude that, variant anatomy of dorsal wall of sacrum make administration of caudal epidural anaesthesia difficult. Elongated sacral hiatus and dorsal wall

agenesis can lead to partial block or complete failure of anaesthesia. So ultrasound or fluoroscopic guidance leads to better patient outcome while giving caudal blocks.

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