

A Study of Non-Fusion of Laminae of First Sacral Vertebra in Western India

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Research Article

Abstract: Background: The sacrum is a large, triangular fusion of five sacral vertebrae which forms the postero-superior wall of the pelvic cavity. Numerous anatomical variations of the bone have been reported. However, non-fusion of the laminae of the first sacral vertebra has never been reported in Gujarati population of Western India. These variations may be found in the patients of low back pain and neurological symptoms during radiological investigations or during epidural anaesthesia in labour and lower abdominal surgeries or on post mortem examination or even during dissection of human body and osteology class for medical students.

Objective: The study was designed to know the prevalence of non-fusion of the laminae of the first sacral vertebra in Gujarati population of Western India. Considering the variation, we conduct this study as a prelude to any type of work for diagnostic and therapeutic purposes in low back pain, spinal surgery and for interventional procedures like epidural anaesthesia and lumbar puncture. **Materials and Methods:** 302 intact dry human sacra of unknown sex were studied from the Department of Anatomy, B.J. Medical college Ahmedabad; Government Dental college, Ahmedabad; Medical college, Vadodara and Government Medical College, Surat in Gujarat. The specimens were carefully examined and non-fusion of the laminae of the first sacral vertebra if found was recorded. **Results:** We found 32(10.6%) out of 302 specimens of sacrum with non-fusion of the laminae of the first sacral vertebra. **Conclusion:** The present study shows that the incidence of sacrum with non-fusion of the laminae of first sacral vertebra in Gujarati population of Western India is 10.6%. Such a non-fusion may lead to clinical procedural failures. It is also important for the accurate diagnosis of patients with low back pain. It may be associated with spina bifida occulta or spina bifida cystica. The knowledge of this anatomical variation is of paramount importance to spinal surgeons, anaesthetists, radiologists, forensic experts, morphologists and clinical anatomists.

Key Words: congenital lumbosacral malformations; dorsal wall of sacral canal; variations of sacrum; spina bifida; epidural anaesthesia.

Introduction

The sacrum is a large, triangular fusion of five vertebrae and forms posterosuperior wall of the pelvic cavity, wedged between two hip bones. Its blunted, caudal apex articulates with coccyx and its superior base with the 5th lumbar vertebra at the lumbosacral angle. The posterosuperior aspect of the dorsal surface bears a raised, interrupted median sacral crest with four (sometimes

three) spinous tubercles which represents fused sacral spines (Figure -1). 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 the failure of the laminae of the fifth sacral vertebra to meet in the median plane and, as a result, the posterior surface of the body of that vertebra is exposed on the dorsal surface of the sacrum⁽¹⁾. If the laminae of first sacral vertebra are not fused, then there will be a gap in the upper part of dorsal wall of the sacral canal (Figure-2). Spina bifida is the generic term for a range of discrete defects of neurulation and subsequent vertebral formation. The spectrum of neural tube and vertebral defects includes a range of open neural defects: craniorachischisis (non-fusion of the entire neural tube and no vertebral arch development); anencephaly (non-fusion of the rostral portion of the neural tube with no calvarial or occipital development); and myelocoele (non-fusion of caudal portion of the neural tube and local failure of vertebral arch development⁽¹⁾). In spina bifida occulta (SBO), the posterior elements of upper sacral vertebrae fail to fuse. If there is non - fusion of the laminae of all the sacral vertebrae, there will be a midline gap^(2,3,4,5). This kind of anatomical variation in the dorsal wall of sacral canal may lead to painful condition of the back^(2,4), some clinical procedural failures^(6,7,8), and also trans-pedicular and lateral mass screw placement failure^(2,9). Thus the knowledge of this anomaly should be kept in mind especially by anaesthetists who perform epidural anaesthesia and orthopaedicians while performing surgical procedures.

In the current study we report non-fusion of the laminae of the first sacral vertebra which is of interest because there have been no published reports in the Gujarati population in Western India. The prevalence rate of such non-fusion is poorly reported in anatomy literature in general. So such a study of non-fusion becomes all the more important for anaesthetists, radiologists, anthropologists and medicolegal experts. Clinical incidence of the failure of epidural anaesthesia and its correlation to non-fusion of the laminae of the first sacral

vertebrae is important. This study is to know the prevalence of non-fusion of lamina of first sacral vertebrae in Gujarat in Western India that in turns help in analgesic management during labour and lower abdominal surgeries.

Materials and Methods

After obtaining permission from the institutes, we examined 302 dry human sacra from the Department of Anatomy, B. J. Medical College, Ahmedabad; Government Dental College, Ahmedabad; Medical College, Vadodara and Government Medical College, Surat, Gujarat, Western India.

Dry human adult intact sacra numbering 302 were studied for non-fusion of the laminae of the first sacral vertebra. Information about the sex of the specimens was not available. Non-fusion of the laminae of the first sacral vertebra was observed, recorded and analyzed (Figure-1).

Results

Examination of 302 intact dry human sacra revealed that 32(10.6 %) sacra had non-fusion of the laminae of the first sacral vertebra. The first sacral spine was absent and there was a gap in the upper part of the dorsal wall of the sacral canal. No other unusual features of the sacrum were found.

Discussion

In the present study, non-fusion of the laminae of the first sacral vertebra was seen in 32(10.6%) sacra out of 302 dry human sacra. Such non-fusion is described as a failure of induction from the roof plate of the neural tube during development which may involve expression of Pax-9, Msx-1 and Msx-2 genes⁽¹⁰⁾. In dry bones, it is not possible to predict whether it was (spina bifida occulta (SBO) or spina bifida cystica during life. Failure of the halves of the embryonic neural vertebral arch to fuse results in a major defect – spina bifida. The incidence of this vertebral defect ranges from 0.04% to 0.15%, and it occurs more frequently in girls than boys. Most cases of spina bifida (80%) are “open” and covered by a thin membrane. A “closed” spina bifida or SBO is covered by a thick membrane or skin. SBO is commonly observed in radiographs of the cervical, lumbar and sacral regions. Frequently only one vertebra is affected. SBO is a relatively minor and insignificant anomaly of the vertebral column that usually causes no clinical symptoms. It can be diagnosed in utero by sonography. It occurs in approximately 20% of vertebral columns that are examined radiographically. The spinal cord and spinal nerves are usually normal and neurologic symptoms are commonly absent. The skin over the bifid vertebral arch is intact, and there may be no external evidence of the vertebral defect. Sometimes the anomaly is indicated by a dimple or a tuft of hair. A severe type of spina bifida

involving protrusion of the spinal cord and/or meninges through the defects in the vertebral arches are referred to collectively as spina bifida cystica because of the cystlike sac that is associated with these anomalies. Spina bifida cystica occurs approximately once in every 1000 births. Neurological symptoms are present in these cases⁽¹¹⁾. The choice of regional anaesthesia in patients with neural tube defects is complicated by

- The increased risk of neural and or dural injury, particularly when conducted at the level of the defect^(12,13)
- abnormal spread of local anaesthetic due to the alteration in structure of the epidural space, resulting in either excessive cranial or inadequate caudal spread^(13,14) and
- The concerns regarding the conduct of regional anaesthesia in patient with established neurology

Effective management of epidural analgesia in patients with spina bifida relies on the understanding that the spinal defect, by distorting and in some cases obliterating the epidural space, can seriously influence the spread of the local anaesthetic solution^(12,13,15).

The advantage of pre-anaesthetic assessment in spina bifida provides the opportunity for^(13,16),

- review by a senior anaesthetist with the relevant notes and X-rays to establish the extent of the defect,
- a base line record of neurological function,
- thorough discussion with the patient, providing informed consent to any regional technique and a realistic expectation of achievable analgesia,
- collection of comprehensive records which could be used as the basis for the creation of a database, either on a local, regional. or national level.

Mehmet et al. (2009) studied a total of 401 male patients and reported 34 (8.5%) of which were spina bifida. SBO was most commonly observed at the S1 level (30 patients)⁽¹⁷⁾. Studies on children with SBO have suggested that new bone formation may occur with increasing age and the defect on posterior arc may be filled up^(17,18). Avrahami et al. (1994) reviewed the lumbosacral CT images of 1200 patients aged 18 to 72 years and reported a higher incidence of SBO at the S1 level in young adults which later was found to decrease with increasing age. Patients with SBO-S1 showed a higher incidence of posterior disc herniation, which increased with age. This can be explained by instability of the base of the lumbar spine caused by SBO-S1, which produces a predisposition to posterior disc herniation. The results were statistically significant^(17,19). The caudal epidural block is widely used for the diagnosis & treatment of lumbar & spinal disorders by orthopaedicians with success rate of 70 - 80%. In about 7.7% of cases the caudal epidural block fails

due to the absence of sacral hiatus & non-fusion of laminae of the first sacral vertebra^(2,3). SBO occurs due to a deficiency of folic acid during pregnancy^(2,5). This kind of anomaly can lead to low back ache, due to the pressure of spinous processes of the fifth lumbar vertebra on the nerve roots through the membrane closing spina bifida^(2,20). Additionally, lack or hypoplasia of posterior elements in SBO can also lead to low back ache. The identification of skeletal remains is one of the classic problems faced by forensic experts. Congenital and acquired malformations can prove to be an important tool for identification⁽²¹⁾. A nonfusion of first sacral vertebrae is one such anomaly that has clinical and medicolegal implications and helps in forensic identification of the deceased, if antemortem medical records exist.

Conclusion

Non fusion of the laminae of the first sacral vertebra is a common deformity and it may lead to clinical procedural failures. A comprehensive awareness and understanding of the lesion and its signs and symptoms will help the orthopaedicians dealing with the case of back pain; it is also helpful for the anaesthetists, surgeons and gynecologists for successful epidural anaesthesia.

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Figure 1: Posterior view- Normal sacrum



Figure 2: Posterior view of a sacrum showing non-fusion of the laminae of the first sacral vertebra.