

A STUDY OF SACRUM WITH FIVE PAIRS OF SACRAL FORAMINA IN WESTERN INDIA

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ABSTRACT

Background: The sacrum is a large, triangular fused five sacral vertebrae and forms the postero-superior wall of the bony pelvis. Numerous anatomical variations of the sacrum have been reported including complete bilateral sacralization of the fifth lumbar vertebra or complete bilateral sacralization of first coccygeal vertebra in different race generates sacrum with five pairs of sacral foramina. There has never been reported among Gujarati population in Western India. These variations may be found in the living during radiological investigations for pain and neurological symptoms of patients or may be found during post mortem examination or during dissection of human body and osteology class for undergraduate students.

Aims & Objective: The study was designed to know the prevalence of sacrum with five pairs of sacral foramina among Gujarati population in Western India as there is paucity of available literature. Considering the variation, we conduct this study as a prelude to any type of experimental work in biomechanics, for diagnostic and therapeutic purposes in low back pain, sciatica, coccydynia, spinal surgery and for interventional procedures like spinal anaesthesia and lumbar puncture.

Material and Methods: Observational study was carried out on 302 dry human sacra from Department of Anatomy, B.J. Medical college Ahmedabad, Government Dental college Ahmedabad, Medical college Vadodara and Government Medical College, Surat in Gujarat. Morphological study was done on the sacrum. The sacra consisting of six vertebral segments were selected. The specimens were then carefully examined and recorded.

Results: 302 dry human sacra were studied. Sacra with five pairs of sacral foramina were recorded. We founded 51 specimens of sacrum with five pairs of sacral foramina representing Bilateral complete sacralization of fifth lumbar vertebra (24 sacra) and bilateral complete sacralization of first coccygeal vertebra (27 sacra).

Conclusion: The prevalence of a sacrum with five pairs of sacral foramina varies in general population is not reported separately. The present study shows that the incidence of sacrum with five pairs of sacral foramina among Gujarati population in Western India is 16.9%. Prevalence of sacrum with five pairs of sacral foramina is 7.9% and 8.9% due to sacralization of fifth lumbar vertebra and sacralization of first coccygeal vertebra, respectively. The knowledge of this anatomical variation is of paramount importance to spinal surgeons, obstetricians, radiologists, forensic experts, morphologists and clinical anatomists.

KEY-WORDS: Congenital Anomaly; Sacralization; Sacral Foramina; Variations of Sacrum; Coccydynia; Low Backache

Introduction

The sacrum is a large, triangular fused five sacral vertebrae and forms the postero-superior wall of the pelvic cavity.^[1,2] Its superior wide base articulates with fifth lumbar vertebra at lumbosacral angle and its blunted caudal apex articulates with coccyx. It has four pair of sacral foramina (figure-1) which communicates with sacral canal. It is expected that any sort of compromise in skeletal features by any pathology, either congenital or acquired will affect the

stability of the spine and its biomechanics. Developmental defects occurring at the lumbosacral border results in sacralization of fifth lumbar vertebra or lumbarization of first sacral vertebra^[2-4] and developmental defects occurring at the sacrococcygeal border results in sacralization of first coccygeal vertebra.

Generally, the sacrum comprises five rudimentary fused vertebrae, but numerous anatomical variations have been reported. The most common anomaly is additional elements yielding a six-

segment sacrum, whereas reduction of sacral constituents is less common.^[2,5,6] Sometimes fifth lumbar vertebra may fuse with the first sacral vertebra (Sacralization of L5) or first coccygeal vertebra may fuse with the apex of sacrum (Sacralization of coccygeal vertebra).^[4] Both condition leads to formation of five pairs of sacral foramina.^[6]



Figure-1: Normal Sacrum – Anterior & Posterior View (Sacrum with four pairs of sacral foramina)

Lumbosacral transitional vertebrae (LSTV) are congenital anomalies of the lumbosacral region which includes lumbarization and sacralization^[2,9] observed for the first time by Bertolotti.^[2,7] This condition occurs due to defect in the segmentation of the lumbosacral spine during development.^[2,8]

In the current study sacrum with five pairs of sacral foramina are formed due to complete bilateral fusion of fifth lumbar vertebra with the first sacral vertebra or complete bilateral fusion of first coccygeal vertebra with fifth sacral vertebra (Sacralization of fifth lumbar vertebra or sacralization of first coccygeal vertebra), the sacrum consisting of six segments. Above process increases one pair of sacral foramina, which is of interest because there have been no published reports about sacrum with five pairs of sacral foramina in Gujarati population in Western India.

The prevalence of the sacralization of fifth lumbar vertebra varies from 1.7% to 14%^[10,11] and sacralization of first coccygeal vertebra varies from 7.8% to 37% in different populations by origin.^[11] So sacrum with five pairs of sacral foramina becomes important for anthropological implications, bioarchiological studies and medicolegal identification. Clinical incidence of backache, sciatica and coccydynia are increasing and its correlation to sacralization is important. This study is to know the prevalence of sacrum with five pairs of sacral foramina in Gujarat in

Western India that in turns help in diagnostic and therapeutic management of illness around lumbosacral and sacrococcygeal region and accurate labelling of vertebral segments is critical before a surgical or percutaneous procedure to avoid wrong level exposure or injection.

Materials and Methods

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

Dry human sacra were studied for numerical variations. Any increases in the number of elements of the sacrum were investigated and identification of six segmented sacrum with five pairs of sacral foramina performed. The specimen with sacralization were examined and recorded.



Figure-2: Sacrum with five Pairs of Sacral Foramina and Complete Bilateral Sacralisation of fifth Lumbar Vertebra – Anterior & Posterior View



Figure-3: Sacrum with five Pairs of Sacral Foramina and Complete Bilateral Sacralisation of first Coccygeal Vertebra – Anterior & Posterior View

We used a two-fold subdivision of sacralization (1) Complete bilateral sacralization of fifth lumbar vertebra (figure-2); (2) Complete bilateral sacralization of first coccygeal vertebra (sacrum with five pairs of sacral foramina (figure -3).

Results

Examination of 302 dry human sacra revealed that 51 sacra had five pairs of sacral foramina. Incidence of sacrum with five pairs of sacral foramina is 16.9%. Incidence of complete bilateral sacralization of fifth lumbar vertebra and complete bilateral sacralization of coccygeal vertebra is 7.9% and 8.9% respectively.

Discussion

The prevalence of a sacrum with five pairs of sacral foramina varies in general population is not reported separately. Our study shows that the prevalence of sacrum with five pairs of sacral foramina is 16.9%. Prevalence of sacrum with five pairs of sacral foramina is 7.9% and 8.9% due to sacralization of 5th lumbar vertebra and sacralization of 1st coccygeal vertebra, respectively.

The importance of the sacrum in the identification of an individual is well known. The sacrum is implicated in the determination of gender, age and stature. It has been studied extensively, probably because of its contribution to the pelvic girdle and the functional differences in the region between the sexes.^[12]

The fifth pair of sacral foramina is generated either due to fusion of first coccygeal vertebra to apex of sacrum or fifth lumbar vertebra with first sacral vertebra. This pair of foramina gives passage to fifth pair of sacral and coccygeal nerve and fifth pair of lumbar nerve respectively. The variant is of paramount importance to surgeons and obstetricians dealing with these nerves.

Sacralization provides no advantage or disadvantage to the individual and is rarely a cause of back problems. The person may remain asymptomatic or may present with clinical symptoms that includes spinal or radicular pain, disc degeneration, L4/L5 disc prolapse and lumbar extradural defects.^[2-4,11,16,17]

The occurrence of sacrum with five pairs of sacral foramina is linked to its embryological development and osteological defects. Vertebrae are derived from the sclerotome portions of the somites, which are derived from paraxial mesoderm. Each vertebra is formed from the combination of the caudal half of one somite and the cranial half of its neighbour.^[2,13] Thus sacralization of fifth lumbar vertebra is caused by the border shifts, cranial shift resulting in the sacralization of fifth lumbar vertebra. Improper formation, migration, differentiation and union of somites results into segmental vertebral abnormalities.^[2,11] Patterning of the shapes of the different vertebrae is regulated by HOX genes. The normal patterning of lumbar and sacral vertebrae as well as the changes in the axial pattern, such as lumbosacral transitional vertebra, results from mutations in the HOX- 10 and HOX -11 paralogous genes.^[2,6,13-15]

Sacrum with five pairs of sacral foramina is not a contraindication to any activity, sports participation or employment, but it may predispose to the possibility of having more back pain or coccygeal pain since this area of the spine is mechanically different to normal.

It is important to identify the sacralization of fifth lumbar vertebra and sacralization of first coccygeal vertebra in patient in whom a surgical or interventional procedure is planned. This is essential to avoid an intervention or surgery at an incorrect level. From a practical view-point, failure to recognize and to number lumbosacral transitional vertebra during spinal surgery may have serious consequences.^[10] Incorrect numbering can theoretically lead to problems with the administration of epidural or intradural anaesthetics in patients with LSTV.^[10] In the operative treatment for disc disorder, it is essential to be alert to the possibility of transitional vertebra.

Normally coccyx is mobile and during second stage of labor, backward movement of coccyx increases the antero-posterior diameter of pelvic outlet, which facilitates delivery. Due to fusion, coccyx becomes fixed and there is no increase in antero-posterior diameter of pelvic outlet. This

may leads to prolonged second stage of labor and perineal tears.^[6]

During medicolegal investigations, some congenital abnormalities are of vital importance in identification, especially when antemortem records are available.^[4] A sacrum with five pairs of sacral foramina is one such congenital anomaly that has clinical and medicolegal implications.

Awareness of this kind of anomaly is of importance while reporting the X-ray, CT and MRI films, during surgical procedures at the lumbosacral or sacrococcygeal region and making a differential diagnosis for low back pain or coccygeal pain in patients respectively.

The knowledge is vital for spinal surgeons, clinical anatomists, forensic experts and morphologists. Hence we have presented such variation with emphasize on its clinical relevance.

Conclusion

The present study shows sacralization leads to formation of five pairs of sacral foramina instead of normally occurring four pairs of sacral foramina in Gujarati population in Western India.

Sacralization results in variation in segmental structure of vertebral column that demands vigilance and modifications during anaesthetic and surgical intervention and it may be associated with non-traumatic lower back pain, sciatica, coccydynia and spinal pathologies. The study of sacrum with five pairs of sacral foramina is of morphological importance in dealing with clinical cases related to lumbosacral and sacrococcygeal region and is helpful for diagnostic and therapeutic purposes. Therefore prevalence of sacrum with five pairs of sacral foramina demands correct clinical and radiological assessment prior to spinal surgery and interventional procedures.

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