RESEARCH ARTICLE

A Study of Sacrum with Three 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 lumbarization of the first sacral vertebra in different race generates sacrum with three 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 first M.B.B.S students.

Objective: The study was designed to know the prevalence of sacrum with three 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, spinal surgery and for interventional procedures like spinal anaesthesia and lumbar puncture.

Materials and Methods: Observational study was carried out on 189 dry human sacra of known sex(115 male and 74 female) were studied 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 four vertebral segments were selected. The specimens were then carefully examined and recorded.

Results: 189 dry human sacra were studied. Sacra with three pairs of sacral foramina were recorded. We founded 3 (1-Male, 2-Female) specimens of sacrum with three pairs of sacral foramina representing Bilateral complete lumbarization of first sacral vertebra. The degree of lumbarization varied: Bilateral complete lumbarization in 3 specimens and did not found Unilateral complete lumbarization specimen.

Conclusion: The present study shows that the incidence of sacrum with three pairs of sacral foramina among Gujarati population in Western India is 1.58 %.The knowledge of this anatomical variation is of paramount importance to spinal surgeons, radiologists, forensic experts, morphologists and clinical anatomists.

Key Words: Congenital Anomaly; Lumbarization; Sacral Foramina; Variations of Sacrum

INTRODUCTION

The sacrum is a large, triangular fused five sacral vertebrae and forms the postero-superior wall of the pelvic cavity.[1] 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 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.[2,3]

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.[4] When the L5 vertebra is fused to the sacrum completely (Sacralization of L5), there are only four lumbar vertebrae, whereas when S1 is separated from the sacrum (Lumbarization of S1), there are six lumbar vertebrae, and many intermediate variations are reported.[3]

Lumbosacral transitional vertebrae (LSTV) are congenital anomalies of the lumbosacral region which includes lumbarization and sacralization[5] observed for the first time by Bertolotti.[6] This condition occurs due to defect in the segmentation of the lumbosacral spine during development.[7]

In the current study sacrum with three pairs of sacral foramina is formed due to non-fusion of the first and second segments of the sacrum so that there is one additional articulating vertebra, the sacrum consisting of only four segments (lumbarization of first sacral vertebra). Above process reduces one pair of sacral foramina, which is of interest because there have been no published reports about complete bilateral lumbarization in Gujarati population in Western India.

The prevalence rate of lumbarization of first sacral vertebra is 3.4% to 7.2%.[8] Prevalence of lumbarization of first sacral vertebra vary in different populations under study. So sacrum with three pairs of sacral foramina becomes important for anthropological implications, bioarchiological studies and medicolegal identification. Clinical incidence of backache is increasing and its correlation to lumbarization is important. This study is to know the prevalence of sacrum with three pairs of sacral foramina in Gujarat in Western India that in turns help in diagnostic and therapeutic management of illness around lumbosacral region and accurate labeling of vertebral segments is critical before a surgical or percutaneous procedure to avoid wrong level exposure or injection.

METHODS

After obtaining permission from institutes we examined 189 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 sacra were studied for numerical variations. Any decreases in the number of elements of the sacrum were investigated and identification of four segmented sacrum with three pairs of sacral foramina performed. The sacra consisting of four vertebrae were selected. The specimen with lumbarization were examined and evaluated for the degree of lumbarization and recorded.

We used a two-fold subdivision of lumbarization (1) Unilateral complete lumbarization (2) Bilateral complete lumbarization of first sacral vertebra (sacrum with three pairs of sacral foramina, Figure -1 & 2).

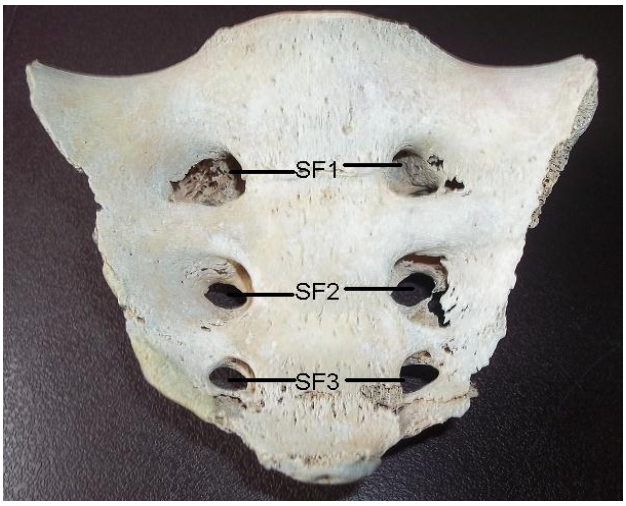

Figure-1: Anterior View of Sacrum with Three Pairs of Sacral Foramina: SF1: First pair of sacral foramina; SF2: Second pair of sacral foramina; SF3: Third pair of sacral foramina.

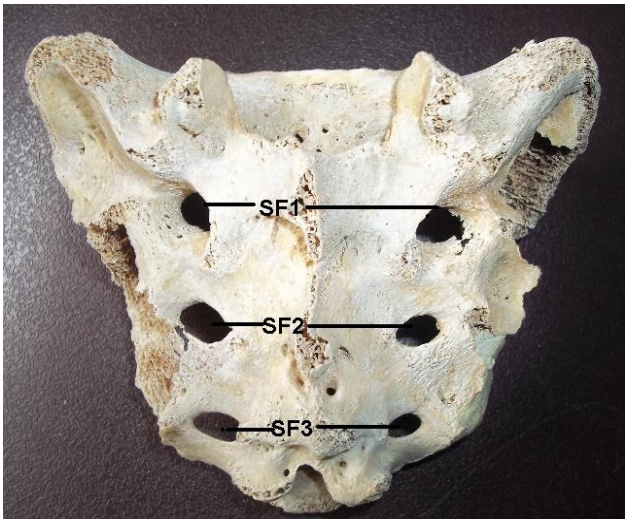

Figure-2: Posterior View of Sacrum with Three Pairs of Sacral Foramina: SF1: First pair of sacral foramina; SF2: Second pair of sacral foramina; SF3: Third pair of sacral foramina.

RESULTS

Examination of 189 dry human sacra revealed that 3 (1.58%) sacra had three pairs of sacral foramina. Incidence of sacrum with three pairs of sacral foramina is 1.58%. Incidence of sacrum with three pairs of sacral foramina is 0.86% and 2.7% in male and female, respectively. We did not report unilateral complete lumbarization in any specimen.

Parameters in sacral samples showing complete separation of S1 were smaller than normal dimension.

DISCUSSION

The prevalence of the lumbarization of first sacral vertebra varies from 4.2% to 9.2% in different populations by origin.[9] The prevalence of a sacrum with three pairs of sacral foramina varies in general population is not reported separately. Our study shows that the prevalence of sacrum with three pairs of sacral foramina is 1.58 %. Prevalence of sacrum with three pairs of sacral foramina is 0.86% and 2.7% in male and female, respectively. We did not report unilateral complete lumbarization in any specimen.

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.[10]

One of the most common anomalies is the presence of a sixth lumbar vertebra, Having one extra lumbar vertebra provides no advantage or disadvantage to the individual and is rarely a cause of back problems. Lumbarization creates a slightly more flexible and unstable spine. 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.[2,3,9,15,16]

Radiologists commonly count down from the last rib when numbering the lumbar vertebral bodies & Surgeons on the other hand, count up from the sacrum when numbering the lumbar vertebra both method of labeling lumbar vertebrae are correct, but it can create confusion. For an individual with five vertebral bodies, they would be in agreement when labeling the L4-L5 level. If the individual has 6 lumbar vertebrae, the radiologist would typically refer to the lowest level as L6-S1 and the level above that L5-L6 which in the surgeons mind would be labeled L4-L5. Spine surgeons & radiologists (Who both may read

and interpret MRI scans) sometimes differ in their method of labeling a particular spinal segment.

The occurrence of sacrum with three 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. During fourth week, sclerotome cells migrate around spinal cord and notochord to merge with cells from the opposing somite on the other side of the neural tube. The sclerotome portion of each somite undergoes a process called resegmentation. Resegmentation occurs when the caudal half of each sclerotome grows into and fuses with the cephalic half of each subjacent sclerotome. Thus each vertebra is formed from the combination of the caudal half of one somite and the cranial half of its neighbor.[11] Thus sacralization of fifth lumbar vertebra and lumbarization of first sacral vertebra are caused by the border shifts, cranial shift resulting in the sacralization of fifth lumbar vertebra and a caudal shift resulting in the lumbarization of first sacral segment.[9] 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.[11,12,13]

Separation of S1 entails alteration of the anatomy at the lumbosacral junction that affects load bearing at the region. Sacrum with three 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 since this area of the spine is mechanically different to normal.

Functionally, a lumbarized S1 usually does not have all the functions of a normal lumbar vertebra. In most instances, this finding is interesting, but does not usually cause pain or disability. In some rare cases the joint may become irritated and painful due to injury.

It is important to identify the lumbarization of first sacral vertebra & sacralization of fifth lumbar 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.[8] Malanga and Cook reported wrong level emergency decompression, in a patient with cauda equina syndrome due to neglecting complete lumbarization of S1.[14] Incorrect numbering can theoretically lead to problems with the administration of epidural or intradural anaesthetics in patients with LSTV.[8] In the operative treatment for disc disorder, it is essential to be alert to the possibility of transitional vertebra.

During medicolegal investigations, some congenital abnormalities are of vital importance in identification, especially when antemortem records are available.[3] A sacrum with three 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 region and making a differential diagnosis for low back pain in patients.

The knowledge is not only enlightening for the spinal surgeons and radiologists, also vital for clinical anatomists, forensic experts and morphologists. Hence we have presented such variation with emphasize on its clinical relevance.

CONCLUSION

The present study shows lumbarization of first sacral vertebra leads to formation of three pairs of sacral foramina instead of normally occurring four pairs of sacral foramina in Guajarati population in Western India.

Lumbarization results in variation in segmental structure of vertebral column that demands vigilance and modifications during anaesthetic

and surgical intervention. It also results in formation of differential active motion segments and may be associated with non-traumatic lower back pain and spinal pathologies. The study of sacrum with three pairs of sacral foramina is of morphological importance in dealing with clinical cases related to lumbosacral region and is helpful for diagnostic and therapeutic purposes. Therefore prevalence of sacrum with three pairs of sacral foramina demands correct clinical and radiological assessment prior to spinal surgery and interventional procedures.

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