

International Journal of Medical Science and Current Research (IJMSCR) Available online at: www.ijmscr.com Volume 2, Issue 5, Page No: 106-111 September-October 2019



# A Study on Variation of Sacral Foramina of Dry Human Sacrum in Rajasthan

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Type of Publication: Original Research Paper

Conflicts of Interest: Nil

#### ABSTRACT

**Introduction:** The sacrum is a large, triangular fused five sacral vertebrae and forms the postero-superior wall of the bony pelvis. Lumbosacral transitional vertebrae are congenital anomalies of the lumbosacral region which includes lumbarization and sacralization. Occurence of five pairs of sacral foramina is an anatomical variation which may be due to sacralisation of fifth lumbar vertebra or first coccygeal vertebra .

Sacralisation of lumbar vertebra may lead to compression of fifth sacral nerve causing backache and sciatica. It may be associated with prolapse of intervertebral disc above the sacralisation. On the other hand sacralisation of coccygeal vertebra may result in prolongation of second stage of labor and perineal tear.

These sacral variations sometimes found in the living during radiological investigations for pain and neurological symptoms of patients or may be found during post mortem examination or routine classes for undergraduate students during osteology demonstration and cadaveric dissection of human body.

**Aims & Objective:** The study was designed to know the prevalence of sacrum with five pairs of sacral foramina. Considering the variation, we conduct this study, 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: Present study was carried out on 80 dry human sacrum of unknown age and gender from Department of Anatomy, S.M.S. Medical college, jaipur and Govt. Medical College, Bharatpur, Rajasthan. Study the morphological features and variations of sacral bones and their foramina were observed.

**Results:** 80 dry human sacra were studied. Sacra with five pairs and three pairs of sacral foramina were recorded. We have observed 3 pairs of anterior sacral foramina with complete lumbarization in one sacrum with an incidence of 1.25%. The presence of 5 pairs of anterior sacral foramina with incomplete sacralization was observed in 3 with an incidence of 3.75%. We founded 6 specimens of sacrum with five pairs of sacral foramina representing Bilateral complete sacralization of fifth lumbar vertebra (4 sacra) and bilateral complete sacralization of 5% and 2.5% respectively.

**Conclusion:** The present study shows that the incidence of sacrum with five pairs of sacral foramina among rajasthani population in India is 12.5%. Prevalence of sacrum with five pairs of sacral foramina is 5% and 6.25% 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.

Keywords: Sacralization, Lumbraization, Sacral Foramina, Variations of Sacrum, Low back pain, Sciatica Coccydynia.

# INTRODUCTION

The sacrum is a large, triangular bone and forms the postero-superior wall of the pelvic cavity.[1,2]

It is formed by the fusion of five sacral vertebrae constituting four pairs of sacral foramina (figure-1). Which communicates with Sacral canal. Sacrum forms two sacroiliac joint with iliac bones and form posterior wall of pelvis. The sacrum has a blunt caudal apex that articulates with the coccyx and its wide base articulates with the fifth lumbar 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

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common.[2,8,9] 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).[10] Both condition leads to formation of five pairs of sacral foramina.[9]

When first sacral vertebrae detaches from sacrum that is called lumbrization, there is only three sacral foramina.(figure-5) 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 [7].



### 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[2,4] observed for the first time by Bertolotti.[2,3] This condition occurs due to defect in the segmentation of the lumbosacral spine during development.[2,5]

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. We also found lumbralization of first sacral vertebrae, here sacrum constitute four segments and three sacral foramina.

The prevalence of the sacralization of fifth lumbar vertebra varies from 1.7% to 14%[6,7] and sacralization of first coccygeal vertebra varies from 7.8% to 37% in different populations by origin.[7] Sacralisation of lumbar vertebra may lead to compression of fifth sacral nerve causing backache and sciatica. It may be associated with prolapse of intervertebral disc above the sacralisation. On the other hand sacralisation of second stage of labor and perineal tear.

So sacrum with five pairs of sacral foramina becomes anthropological implications, important for medicolegal bioarchiological studies and identification. Clinical incidence of backache, sciatica and coccydynia are increasing and its correlation to sacralization is important. This study is helps 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**

Present study was carried out on 80 dry human sacrum of unknown age and gender from Department of Anatomy, S.M.S. Medical college ,jaipur and Govt. Medical College, Bharatpur, Rajasthan.

Damaged, mutilated & deformed sacra were excluded.

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 and lumbrization 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



Figure-4: Sacrum with five Pairs of Sacral Foramina and Incomplete Bilateral Sacralisation of first Coccygeal Vertebra – Anterior & Posterior View



Figure-5: Sacrum with three Pairs of Sacral Foramina and Complete Bilateral lumbralisation of first sacral Vertebra – Anterior & Posterior View

We studied

(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).

(3) Incomplete bilateral sacralization of first coccygeal vertebra (sacrum with five pairs of sacral foramina (figure -4).

(4) Complete Bilateral lumbralisation of first sacral Vertebra (Sacrum with three Pairs of Sacral Foramina) (figure -5).

#### Results

Examination of 80 dry human sacrum revealed that 3 pairs of anterior sacral foramina with complete lumbarization in one sacrum with an incidence of 1.25%. The presence of 5 pairs of anterior sacral foramina with incomplete sacralization was observed in 3 with an incidence of 3.75%. We founded 6 specimens of sacrum with five pairs of sacral foramina representing Bilateral complete sacralization of fifth lumbar vertebra (4 sacra) and

bilateral complete sacralization of first coccygeal vertebra (2 sacra) with incidence of 5% and 2.5% respectively.

Incidence of sacrum with five pairs of sacral foramina is 12.5%. Incidence of complete bilateral sacralization of fifth lumbar vertebra and complete

bilateral sacralization of coccygeal vertebra is 5% and 6.25% respectively (Table-1).

**Table 1** The incidence of lumbar and coccygealsacralisation and lumbrization in sacra showing afifth pair and three pair of of sacral foramina in thepresent study.

s.no.	Category	Frequency	Incidence (%)
1.	Complete Lumbar sacralisation	4	5%
2.	Incomplete Lumbar sacralisation	0	0%
3.	Complete Coccygeal sacralisation	2	2.5%
4.	Incomplete Coccygeal sacralisation	3	3.75%
5.	Complete Lumbarization	1	1.25%
6.	Total Lumbar sacralisation	4	5%
7.	Total Coccygeal sacralisation	5	6.5%

### 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 12.5%. Prevalence of sacrum with five pairs of sacral foramina is 5% and6.25% due to sacralization of 5th lumbar vertebra and sacra-lization of 1st coccygeal vertebra, respectively. We also observed 3 pairs of anterior sacral foramina with complete lumbarization in one sacrum with an incidence of 1.25%.

The importance of the sacrum in the identification of an individual is well known.

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. **[1,2,6.10,12,17]** 

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.[2,11] Thus sacralization of fifth lumbar vertebra is caused by the border shifts, cranial shift resulting in the sacralization, differentiation and union of

somites results into segmental vertebral abnormalities.[2,7]

Sacralization of the fifth lumbar vertebra or lumbarization of the first sacral vertebra as seen in the present study could have been due to mutation of HOX gene [14,15].

Singh[9] who has reported an incidence of 16.6% of sacralisation .Swargam et al[17] have reported the incidence of lumbar sacralisation in their study as 10%.

Shaileshkumar Nagar et al.[18] have reported 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.

Kumar MP *et al* [19]observed 3 pairs of anterior sacral foramina with complete lumbarization in one sacrum with an incidence of 2%. The presence of 5 pairs of anterior sacral foramina with incomplete sacralization was observed in one sacrum(2%) sacral bones.

Rajani reported a case with five pairs of sacral foramina [7] However Goswami et al[13]have reported the incidence of lumbar sacralisation as 2.5%

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.

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. Thismay leads to prolonged second stage of labor and perineal tears.[9]

Sacrum with 3 pairs of sacral foramina is linked to embryological development and osteological

defects. Vertebrae are derived from the sclerotome portions of the somites, which are derived from paraxial mesoderm. [7,11]

During medicolegal investigations, some congenital abnormalities are of vital importance in identification, especially when antemortem records are available.[6].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 rajasthan.

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 nontraumatic lower back pain, sciatica, coccydynia and spinal pathologies. The knowledge is vital for spinal surgeons, clinical anatomists, forensic experts and morphologists.

Sacralisation not only poses a challenge in anaesthetic and obstetrics practice but also indicates that defective regulation of Homeobox and Pairedbox genes may be the basis of the anatomical variation. Therefore variation of sacral foramina of sacrum demands correct clinical and radiological assessment prior to spinal surgery and interventional procedures.

# References

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#### Dr. Manish Kumar Singhal et al International Journal of Medical Science and Current Research (IJMSCR)

- 1. Borley NR. True pelvis, pelvic floor and perineum. In: Standring S editor. Gray's Anatomy: The Anatomical Basis of Clinical Practice. 40th Ed., London, Churchill Livingstone.2011; 724–728.
- Kubavat DM, Nagar SK, Lakhani C, Ruparelia SS, Patel S, Varlekar P. A study of sacrum with three pairs of sacral foramina in Western India. Int J Med Sci Public Health 2012; 1:127-131.
- Delport EG, Cucuzzella TR, Marley J, Pruitt C, Delport AG. Lumbosacral transitional vertebrae: incidence in a consecutive patient series. Pain physician. 2006. 9(1):53-56.
- Kim NH, Suk KS. The role of transitional vertebrae in spondylolysis and spondylolytic spondy-lolisthesis. Bull Hosp Jt Dis. 1997;56(3):161-6.
- Eyo MU, Olafin A, Noronha C, Okanlawon A. Incidence of lumbosacral transitional vertebrae in low back pain patients. West Afr J Radiol. 2001. 8(1):1-6.
- 6. Bron JL, Van Royen BJ, Wuisman PJ. The clinical significance of lumbosacral transitional anomalies. Acta Orthopaedica Belgica, 2007. 73(6):687-695.
- Sharma VA, Sharma DK, Shukla CK. Osteogenic study of lumbosacral transitional vertebra in central India region. J Anat Soc India. 2011. 60(2): 212-217.
- Frymoyer JW, Hadler NM, Kostuik JP, Weinsttein JN, Whitecloud TS (editors). The Adult Spine: principles and practice. vol 2. New York: Raven press, 1991: 2099.
- 9. Singh R. Sacrum with five pairs of sacral foramina. Int J Anat Var. 2011. 4;139-140.
- 10. Kanchan T, Shetty M, Nagesh KR, Menezes RG. Lumbosacral transitional vertebra:

clinical and forensic implications. Singapore Med J. 2009 Feb;50(2):e85-87.

- 11. Sadler TW; Langman's Medical embryology.11th edition, Lippincott Williams & Wilkins,
- 12. Philadelphia 2010: 142.
- 13. Hollinshead WH. Anatomy for surgeons, Vol.3: The back and limbs. 1st ed. London: The back Hoeber- Harper publication; 1961:92-119.
- 14. Goswami P, Yadav Y, Chakradhar V. Sacral Foramina: Anatomical Variations and Clinical Relevance in North Indians; European Journal of Academic Essays; 2014; 1(4); 29-33.
- 15. Carapuco M, Novoa A, Bobola N, Mallo M. Hox genes specify vertebral types in the presomitic mesoderm. Genes Dev. 2005;19:2116-2121.
- Wellik DM, Capecchi MR. Hox 10 and Hox 11 genes are required to globally pattern the mammalian skeleton. Science. 2003;301:363-367.
- 17. Castellvi AE, Goldstein LA, Chan DP. Lumbosacral transitional vertebrae and their relationship with lumbar extradural defects. Spine. 1984,9;493-495.
- Swargam N, Chandruptla M. Sacralisation of fifth lumbar vertebra; International Journal of Recent Scientific Research; June, 2014;Vol. 5; Issue 6; 1159-1160.
- 19. Shaileshkumar Nagar et al. Sacrum with Five Pairs of Sacral Foramina. International Journal of Medical Science and Public Health ;2013 ;Vol 2 ; Issue 2; 243-246.
- 20. Kumar MP *et al.*, A Study on Anterior Sacral Foramina and Their Variations in South Indian Population Sch. J. App. Med. Sci., 2015; 3(3C):1196-1198.