



SACRALIZATION OF LUMBAR VERTEBRAE-ITS ANATOMICAL, EMBRYOLOGICAL AND CLINICAL PERSPECTIVE

Dr. Rekha Bhasin*	Post MD Demonstrator , Anatomy department GMC, Jammu *Corresponding Author
Dr. Sajad Hamid	Faculty , jk medical college
Dr. Sunanda Raina	Prof. And HOD Anatomy, GMC, Jammu

ABSTRACT

BACKGROUND: Vertebral column have very important role in weight transmission and to maintain posture of our body. Stress and strain of vertebral column are increasing from above downward. Lumbosacral region have more stress and strain and low back pain is very common in this region. Sacrum consists of five fused sacral vertebrae. These are fused to provide strength and stability to the pelvis and transmit the weight of the body to the pelvic girdle through the sacro-iliac joints. The vertebral .Lumbosacral transitional vertebrae (LSTV) are congenital anomalies of the lumbosacral region, which includes sacralisation of fifth lumbar vertebra and lumbarisation .Low back pain is quite a common ailment affecting about 80% of the population in their life time. This abnormality can be diagnosed by plain radiography. Sacralization leads to narrowing of disc space between L5 and S1, so there is higher chance of disc herniation and disc degeneration (9). Sacralization can lead to narrowing of intervertebral foramina causing compression of spinal nerve which can cause spinal or radicular pain

MATERIALS AND METHODS: In the present study 30 adult human sacra were examined in the department of Anatomy, Govt. Medical College in The State of Jammu & Kashmir.

OBSERVATIONS AND RESULTS: In the present study of 30 adult human sacra 21 were male and 9 were female sacra. Out of 30 sacral bones 3 sacra showed sacralisation of fifth lumbar vertebrae.

CONCLUSION: Knowledge of sacralisation is not only enlightening for the orthopaedic surgeons, also vital for the Clinical Anatomists, Radiologists, Forensic experts, Morphologists, Architectures and Anthropologists.

KEYWORDS : Sacralisation, Lumbar vertebra, Sacrum, Genes, Low back pain.

INTRODUCTION

Sacrum is a large triangular bone formed by fusion of five sacral vertebrae. These are fused to provide strength and stability to the pelvis and transmit the weight of the body to the pelvic girdle through the sacro-iliac joints. The vertebral column can bear a weight of nearly 355 kg without crushing and a tearing strain of nearly 152 kg. Its weakest part is in the neck, which normally carries least weight [1]. It lies obliquely at the upper and posterior part of pelvic cavity between two hips bone. Because of its oblique position it forms an angle with rest of vertebral column known as sacrovertebral or Lumbosacral angle [2]. Lumbosacral transitional vertebrae (LSTV) are congenital anomalies of the lumbosacral region, which includes sacralisation of fifth lumbar vertebra and lumbarisation of first sacral vertebra observed for the first time by Bertolotti in 1917. This condition occurs due to defect in the segmentation of the lumbosacral spine during development [3].

Lumbosacral transitional vertebra (LSTV) is a common congenital anomaly of lumbosacral region, which includes sacralization and lumbarisation and it is frequently encountered. Sacralization is a congenital condition in which usually the fifth lumbar vertebra fuses completely or partially with sacrum unilaterally or bilaterally. In lumbar sacralization usually L5 and rarely L4 along with L5 fuses with sacrum . In coccygeal sacralization coccyx fuses completely or partially with sacrum. Lumbarisation of first sacral vertebra is a condition in which the first sacral vertebra is not completely attached to its fused sacral components but instead this first sacral vertebra appears like the other lumbar vertebrae. It occurs due to non-fusion of first and second sacral segments.

Sacralisation of L5 is a congenital anomaly in which the lumbar vertebra mainly its transverse process gets fused or semi fused with sacrum or the ilium or to both. This can be on one or both sides of the body. Sometimes it is observed that the lumbar vertebral body is not fused but only transverse process is fused with sacrum, completely on one side and incompletely on other side. When fusion occurs with body of sacrum it is central sacralization and when fusion of transverse process occurs it is transverse sacralization which may be unilateral or bilateral. After sacralization L4 becomes last lumbar

vertebra and L4 vertebra lack the ability to perform function like L5 and cause problems. It is difficult for L4 to cope with increased demand causing overuse and undue strain to the disc between L4 and L5. This usually leads to pain and discomfort in region of low back. Sacralization can lead to narrowing of intervertebral foramina causing compression of spinal nerve which can cause spinal or radicular pain [4]. Sacralization can lead to narrowing of intervertebral disc which can cause disc prolapse or disc degeneration [5]. Low back pain is quite a common ailment affecting about 80% of the population in their life time [6] and it may also cause greater difficulty during labour. This abnormality can be diagnosed by plain radiography. Knowledge of sacralisation is not only enlightening for the orthopaedic surgeons, also vital for the Clinical Anatomist, Radiologists, Forensic experts, Morphologists, Architectures and Anthropologists. In order to understand sacralization of lumbar vertebra it is necessary to first understand the normal anatomy of lumbar and sacral vertebrae as well as the embryological development of the human vertebral column and the factors that can lead to developmental variation. Further, it is necessary to review the ossification process in order to identify possible defects that can arise at that stage. Lumbar vertebra is irregular, having large body, stout pedicles and thick lamina It shows slender transverse processes, short, thick, square spinous processes. Lumbar vertebrae are known for their characteristic biomechanics. Biomechanics and function of lumbar vertebra is to support the upper body, transfer weight from axial to appendicular skeleton, and provide mobility in the lower back. Lumbar vertebra strong enough to support the upper body and yet flexible enough to allow the needed mobility. But at the same time if anything subject to failure, which may cause low back pain. Thus the present study is carried out to know the proportion and type of sacralisation of the fifth lumbar vertebra.

MATERIAL AND METHODS

The study was conducted in the department of Anatomy Govt. Medical College, Jammu. We have studied thirty sacral bones of both sexes male and female. All the sacra were observed for sacralization, lumbarisation, number of ventral and dorsal sacral foramina,

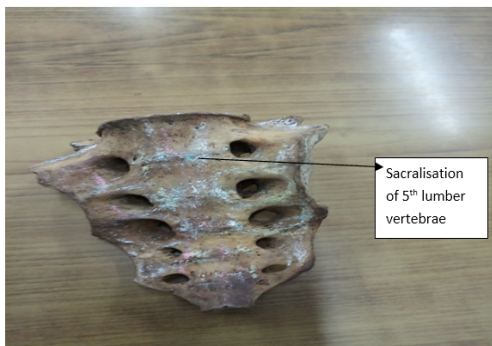
number of vertebral bodies, sacral hiatus and sacral cornua. All the observations were noted and tabulated. Damaged, mutilated and deformed sacra were excluded. Data was collected by naked eye observation for different types of sacralisation of fifth lumbar vertebra depending on fusion (complete and incomplete) and right or left side sacralisation.

Sacralised sacra were classified as follows:

1. Complete fusion between the fifth lumbar vertebra and the first sacral vertebra.
2. Incomplete fusion between the fifth lumbar vertebra and the first sacral vertebra.
3. Bilateral sacralisation consists of a bony union between the abnormal transverse process and the sacrum on both sides.
4. Unilateral sacralisation shows a bony union between the abnormal transverse process and the sacrum either on right side or left side.

OBSERVATIONS

In the present study out of thirty sacral bones there were 21 male sacral bones and 9 female sacral bones. We found sacralization of fifth lumbar vertebrae in three male sacral bones. So sacralization was found in 10% cases. In all the cases sacralization was bilateral. In these sacralised bones body was completely fused.



Sacralization of lumbar vertebra front view

DISCUSSION

Based on the literature, the incidence of sacralisation varied by the following races.

The incidence in our study was close to the races like Australian aboriginals 18%, South Asians 16% reported by Mitchell and Bustami F respectively and much higher than the races like Americans 3.6%, Natives of Britain 8% and Arabs 10%. The incidence of sacralisation was close to the authors reported like Steinberg 14%, Vandana Sharma 14%, and the incidence was higher than the authors reported like Kim 1.7%, Hughes 9.2%, Hald 7.8%, Hahn 7.5%, Kubavat 11.1%, Chithrika 5%. The incidence among Gujarati population is 11.1% which is more in males than females and Central India region is 14% [14]. In our present study we found sacralization in three (10%) cases. All the sacralised bones were male sacrum which shows that the incidence of sacralization is more common in males. Eyo et al. (2001), in his study he found that the incidence ratio of sacralization to lumbarisation was 2:1 and this condition was more common in males [7]. Magora and Schwartz (1978) found sacralization in 20.8% of cases [8]. Castellvi et al (1983) reported incidence of sacralization may be 1.7% to 14%, he also gave radiological classification system for sacralization [9]. Chet Savage (2005) reported 7% sacralization (10). Sharma et al (2011) reported sacralization in 14.1% of cases in central India (12). Our study was close to Dharati K et al who found sacralization in 11.1% of cases (13). J.L. Brow in a systematic review on the subject analysed all the relevant studies from 1986 till 2006 and documented that the mean prevalence of sacralization to be 12.3%.

Sacralization is basically related to embryological development of vertebra and sacrum. During 3rd week of intrauterine life segmentation of paraxial mesoderm starts to form somites on either side of notochord along the cranio caudal axis. These somites differentiate further into dermomyotome and sclerotome. Each sclerotome consists of loosely packed cells cranially and densely packed cells caudally. Some densely packed cells move cranially opposite the centre of myotome where they form intervertebral disc. The remaining densely packed cells fuses with the loosely arranged cells of immediately caudal sclerotome to form mesenchymal centrum (body of vertebra). The mesenchymal cells of sclerotome surrounding the neural tube form neural arch. Ossification of vertebra begins in 8th week and end by 25th year of life. There are 3 primary centres for each sacral vertebra, 1 for body and 2 for each arch which appears between 10th to 20th weeks. 6 primary centres for costal elements of upper 3 sacral vertebrae appears in pairs one on each side. There are 5 secondary centres present in each vertebra, one for spinous process, one for tip of each transverse process and 2 for annular epiphysis. Thus sacrum has 21 primary centre and 14 secondary centres and completes ossification occurs at 25 years of age. Ossification from 3 primary centres and 7 secondary centres occurs in lumbar vertebrae that fuses between 17 to 25 years of age. Any defect in these ossification centres leads to variant morphology of the vertebrae [12]. The primary cause of Lumbosacral transitional vertebra (LSTV) is cranial shift that means sacralization of last lumbar vertebra and partial shift means unilateral fusion of transverse process. Caudal shift results in lumbarisation of first sacral vertebra, cranial shift is dominant over caudal shift. So sacralization is more common than lumbarisation [12]. The improper formation and union of somites can cause vertebral abnormalities including block vertebrae, cleft vertebra or hemivertebrae. The development of vertebra and sacrum is regulated by homeobox and paired box genes pax1 and pax9 which control cell proliferation during sclerotome development. As revealed in mice that deficiency of pax1 and mutation of pax9 leads to vertebrae malformation in lumbar region. There are genetic determinants leading to sacralization. This hypothesis was supported by a previous study of Tini (1977) as increased incidence of Lumbosacral transitional vertebra were observed occurring within families

Bertolotti (1917) described the relationship between low back pain and sacralization of L5 which is known as Bertolotti syndrome (14). In young patient with low back pain the possibility of bertolotti syndrome should always be taken in account. Back pain in sacralization is due to pressure on nerve or ligamentous strain around the sacralization. Aihara et al in an anatomical study of 70 cadavers claimed that the iliolumbar ligament at the level immediately above the transitional vertebra is much thinner and weaker than in cadavers without a lumbosacral transitional vertebra [5]. Lumbosacral transitional vertebra is associated with disc herniation, sciatic pain and scoliosis in some individuals. Failure to recognize the transitional vertebra during spinal surgery may cause serious complications. In sacralization pelvis may fails to expand during labour leading to difficulty in delivery of baby.

CONCLUSION

Knowledge of sacralization or lumbarisation is very important for orthopaedic and neurosurgeons operating in this region to avoid surgery at incorrect level, and also for anaesthetists during administration of epidural, subdural and caudal anaesthesia. It is also very important for radiologists while reporting x-ray, CT and MRI for correct clinical and radiological assessment and for physicians to rule out secondary spinal disorders like disc herniation, disc degeneration, facet arthritis and radicular pains.

REFERENCES

- [1]. Romanes G.J. Cunningham's text book of Anatomy, 10th edition, Oxford University press, London; 1964:92-93.
- [2]. Standring S, Gray's Anatomy, The anatomical basis of clinical practice, 40th Ed. London, U.K, page. no 724-728.
- [3]. Standring S. Gray's Anatomy: The Anatomical Basis of Clinical Practice, 40th edition, Churchill Livingstone Elsevier, London; 2008:728.

- [4]. Otani K, Konno S, Kikuchi S, Lumbosacral transitional vertebra and nerve root symptoms. *J Bone Joint Surg Br.* 2001;83 (8):1137-40.
- [5]. Aihara T, Takahashi K, Ogasawara A, Itadera E, Ono Y, Moriya H; Intervertebral disc degeneration associated with Lumbosacral transitional vertebrae: a clinical and anatomical study. *J Bone Joint Surg Br.*, 2005;87(5):687-691.
- [6]. Dullerud R. Diagnostic imaging in lumbago and sciatica. *Ugeskr Laeger* 1999;161:5299-303.
- [7]. Eyo MU, Olofin A, Noronha C, Okanlawon A: Incidence of Lumbosacral Transitional Vertebrae in Low Back Pains, Patients West African Journal of Radiology, April 2001: 8(1).1-6.
- [8]. Magora A, Schwartz A. Relation between the low back pain syndrome and X-ray findings. Transitional vertebra (mainly sacralization) *Scan J Rehabil Med* 1978, 10: 135-45
- [9]. Castellvi AE, Goldstein LA, Chan DPK: Lumbosacral transitional vertebra and their relationship with lumbar extadural defects. *Spine* 1983, 9:493-495
- [10]. Peter H, Wilm B, Sakai N, Imai K, Maas R, Balling R: Pax 1 & Pax 9 synergistically regulates vertebral column Development 1999, 126:5399-408.
- [11]. Chet Savage. Lumbosacral Transitional Vertebrae: Classification Of Variation and Association with Low Back Pain A Thesis presented to the Faculty of the Graduate School University of Missouri-Columbia; July: 2005.
- [12]. Sharma V. A., Sharma D. K., Shukla C. K. (2011). Osteogenic study of Lumbosacral transitional vertebra in central India region. *J. Anat. Soc. India.* 60:212-217
- [13]. Kubavat Dharati, Nagar S K, Malukar Ojaswani, Trivedi Dipali, Shrimankar Paras, Patil Sucheta: National journal of medical research, Vol.2(2), apr-june 2012
- [14]. Bertolotti M. (1917). Contributo alla conoscenza dei vizi di differenziazione regionale del rachide con speciale riguardo all'assimilazione sacrale della V lombare. *Radiol. Med.* 4:113-144.