

Sacral Foramina: Anatomical Variations and Clinical Relevance in North Indians

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Abstract : Lateral side of each intermediate crest has four dorsal sacral foramina for the passage of posterior division of the sacral nerves. Not only they serve as an important landmark in placement of spinal instrumentation but are also of great importance in trans-sacral block of sacral nerves for producing analgesia and anesthesia in pelvic surgeries. Therefore a study on the variation in number of dorsal sacral foramina was conducted in 80 adult dry North Indian sacra. Three dorsal sacral foramina were seen on the lateral side of each intermediate crest in two sacra (2.5%) and five in 2 sacra (2.5%) amongst all the sacra examined. This study revealed that there is variation in the number of dorsal sacral foramina. Anesthetists should be aware of this disparity to be able to perform trans-sacral nerve block successfully. Radiologists must also know about this variation to interpret the radiographs of lumbo-sacral region. Neurologist and orthopedist should also be cognizant of this fact to diagnose patients presenting with bizarre clinical findings.

Keywords: Dorsal sacral foramina, Ventral sacral foramina, Intermediate crest, Spinal instrumentation, Sacrum

1. Introduction

Sacrum is the most variable portion of spine as a number of anatomical variations occur in this region quite frequently [1]. Lateral to the intermediate crest on the dorsal aspect of sacrum are four dorsal sacral foramina (Figure 1), which transmit the posterior division of sacral nerves and there are four pairs of pelvic sacral foramina which transmit the anterior division of sacral nerves [2] (Figure-2). Occasionally, the first sacral vertebra is not fused to other four segments of sacrum (lumbarization of first sacral vertebra) resulting in three sacral foramina (Figure 3, 4) or the fifth lumbar vertebra fuses with the first sacral vertebra (sacralization of fifth lumbar vertebra) leading to formation of five pairs of dorsal sacral foramina (Figure 5,6). As they serve as an important landmark in spinal instrumentation and can also be used for blocking sacral nerves trans-sacrally in order to produce analgesia and anesthesia in the surgeries involving pelvic region therefore, it becomes essential to know the frequency of variation in the number of dorsal sacral foramina. Deficient literature is available on dorsal sacral foramina in North Indians, hence this study was conducted. Embryological origin and clinical significance of its variable number have been discussed in the paper.

2. Methods

Eighty adult dry human sacra were grossly examined. The number of dorsal sacral foramina in each of the sacrum was counted. The result obtained was analyzed and discussed.

3. Results

Three pairs of dorsal sacral foramina were present lateral to intermediate crest in 2 sacra (2.5%) and five pairs of dorsal sacral foramina were seen in 2 sacra (2.5%) Rest of the sacra showed the normal four pair of foramina. No sacrum showed either a single or double pair or a total absence of dorsal sacral foramina.

4. Discussion

Normally, sacrum is formed by fusion of five sacral vertebrae which results in formation of four pairs of sacral foramina [3]. The upper four sacral nerve roots exit the sacrum through paired dorsal and ventral sacral foramina. Fifth sacral and coccygeal roots and the filum terminale exit the sacrum caudally through the sacral hiatus [4].



Figure 1: Showing dorsal aspect of adult dry sacrum. Normally, four pairs of dorsal sacral foramina are seen lateral to intermediate crest



Figure 2: Showing ventral aspect of adult dry sacrum. Normally, four pairs of pelvic sacral foramina



Figure 3: Showing ventral view of the adult dry sacrum. Three pairs of ventral sacral foramina are seen



Figure 4 : Showing dorsal aspect of the adult dry sacrum having three pairs of dorsal sacral foramina lateral to intermediate crest of sacrum



Figure 5: Dorsal aspect of the adult dry sacrum showing five pairs of dorsal sacral foramina lateral to intermediate crest of sacrum

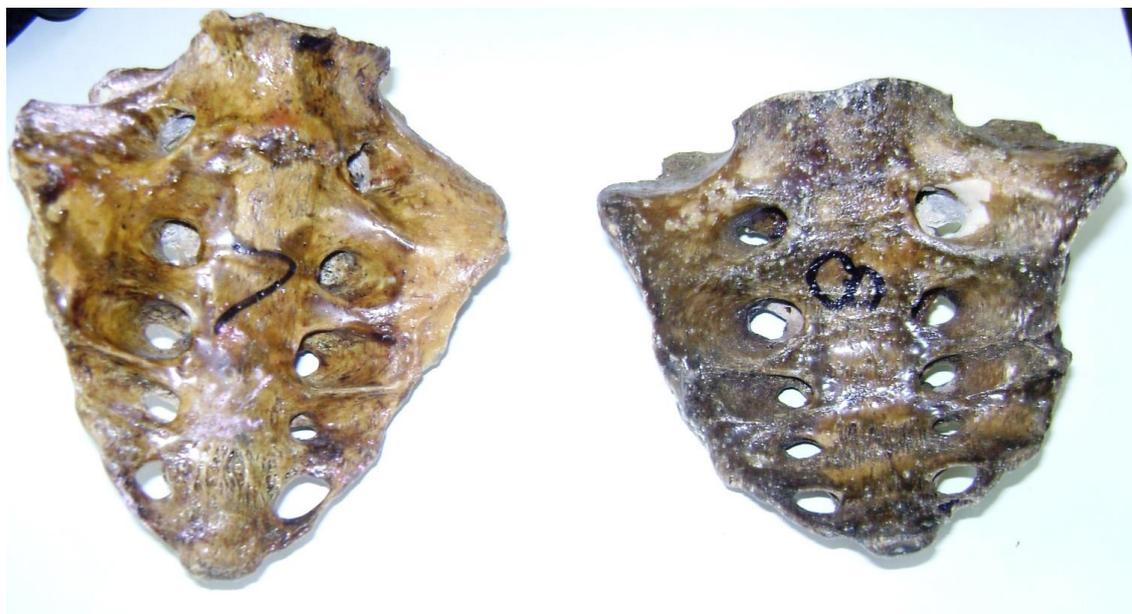


Figure 6: Ventral aspect of the adult dry sacrum showing bilateral complete sacralization of fifth lumbar vertebra resulting in five pairs of ventral sacral foramina.

Lumbarization of the first sacral vertebra is said to occur when the uppermost segment of the sacrum is not fused to other four segments of sacrum. Rather the first sacral vertebra is mobile and participates along with the neighboring lumbar vertebrae in spinal activities [5]. The resultant sacrum will have four vertebrae instead of five as in the normal sacrum and will have three sacral foramina along the pelvic and dorsal aspect of sacrum. Although few authors have mentioned presence of three sacral foramina in their study [6, 7] but no literature was available on the variation in number of the sacral foramina in North Indian population. In the present study, three sacral foramina were observed in 2 out of a total number of 80 sacra examined. Radiographic studies conducted by Paul (1938) on one thousand patients who complained of pain in the lower part of the back and legs suggested that approximately 30 per cent showed an anomaly of the lumbo-sacral spine [8]. If such an anomaly exists then there is all possibility that the fourth sacral nerve roots also passes through the sacral hiatus along with the fifth sacral, coccygeal roots and the filum terminale exiting through it. In that case, any sacrococcygeal tumour may compress upon fourth sacral roots also, leading to neurological involvement of the bladder and rectum. Physicians, Surgeons and Uro-surgeons must be aware of the presence of such variation while dealing with unusual clinical findings. However Pamela suggested that the patients are frequently told that a spinal anomaly observed in their radiograph is the cause of their back problems. But the anomalies in the lumbar and sacral spine are simply variants of the normal bony architecture and are typically of no consequence. It would be very rare for an abnormality such as a sixth lumbar vertebra or extra sacral segment to cause back problems [9].

Five pairs of sacral foramina were also seen in 2 sacra in the present study. When fifth lumbar vertebra fuses with the first sacral vertebra, it is known as sacralization of lumbar

vertebra and when first coccygeal vertebra fuses with the apex of sacrum, it is known as sacralization of coccygeal vertebra. The processes described above leads to formation of an additional fifth pair of sacral foramina [10]. Rajani reported a case with five pairs of sacral foramina [11]. The fifth pair developed due to sacralization of coccyx. This pair of foramina gives passage to fifth pair of sacral and coccygeal nerves. This variant is of importance to surgeons and obstetricians dealing with these nerves. Rajani is of the opinion that due to fusion of sacrum and coccyx as was seen in her study, antero-posterior diameter of pelvic outlet does not increase during second stage of labour which may lead to prolonged labour and perineal tears [11] In the present study, all the sacra seen with five pairs of sacral foramina were male specimen (Figure 4, 5, 6). Simultaneous fusion of fifth lumbar vertebra with the cranial end of the first sacral vertebra and fusion of first coccygeal vertebra with the caudal end of fifth sacral vertebra may lead to formation of six pairs of sacral foramina as suggested by Bergman, Afifi and Miyauchi[12]. In the present study no sacrum was seen to possess 6 pairs of foramina. Sadler is of the opinion that HOX gene is responsible for patterning of the shapes of vertebra [13]. 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 as was suggested by Sadler. Other less common etiologies may be arthritic changes, traumatic injury and intentional spinal fusion surgery. The observations made by renowned anatomists and surgeons several years ago, still holds true. But one needs to learn a lot to keep pace with recent advances in surgical methods and instrumentation in the lumbosacral region. Obstetricians, radiologists, anaesthetists, neurologists and orthopedic surgeons must know about the existence of this variation to be able to correctly investigate, diagnose and treat the patients presenting with unusual signs and symptoms.

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