

# An aperture in the sagittal plane of the dorsal wall of the sacrum

G. Tsoucalas<sup>1</sup>, E. Panagouli<sup>2</sup>, A. Vasilopoulos<sup>1</sup>, V. Thomaidis<sup>1</sup>, M. Piagkou<sup>2</sup>, A. Fiska<sup>1</sup>

<sup>1</sup>Anatomy Department, Medical School, Democritus University of Thrace, Alexandroupolis, Greece

<sup>2</sup>Anatomy Department, Medical School, National and Kapodistrian University of Athens, Athens, Greece

[Received: 12 February 2019; Accepted: 22 April 2019]

*The dorsal wall of the sacrum presents various anatomical variations, while the dorsal bony wall of the sacral canal suffers more. We report a case of a sacrum with a series of variants in the midline due to abnormal ossification and a bizarre aperture on the sagittal plane between the 1<sup>st</sup> and the 2<sup>nd</sup> sacral spinous processes. A failure of the ossification patten during embryological life, or an ossification of the supraspinous ligament may result in such an aperture. Sacrum variety is of great importance for the daily proper medical practice. (Folia Morphol 2020; 79, 1: 179–181)*

**Key words:** sacral canal, agenesis, ossification, supraspinous ligament, midline

## INTRODUCTION

Sacrum depicts the most variable part of the vertebrae column in human anatomy. It is a triangular bone formed by the fusion of five sacral vertebrae. It presents a concave anterior or pelvic surface and a convex posterior one, placed as a wedge between the two innominate bones at the upper and posterior part of the pelvic bone. Various foramina (sacrals and variation openings) and a canal supplement its anatomy. The opening present at the caudal end of sacral canal is known as sacral hiatus which is formed due to the failure of fusion of laminae of the 5<sup>th</sup> (occasionally 4<sup>th</sup>, or 3<sup>rd</sup>, and 2<sup>nd</sup> as variations) sacral vertebra [2, 4].

The sacrum is formed during a complex developmental process by the fusion of 58 to 60 ossification centres. The osseous maturation spans a period which starts from the end of the first trimester of the foetal life and lasts until the mid-adult life [1]. A disturbance in ossification process may result a plethora of anatomical variations, especially in the dorsal wall of the sacrum [4].

## CASE REPORT

The sacrum in report belongs to a human skeleton of Caucasian (Hellenic) origin which was examined during educational study among the skeletons newly donated at the Anatomy Department of the Medical School of the Democritus University of Thrace. The donated skeleton belonged to a female of unknown age. The skeleton derived from skeleton donation with informed consent (with signature authentication) by the donator himself.

Our bone has a base presenting a transverse diameter of the sacral segment of 70.8 mm and an anterior-posterior diameter of the sacral segment of 32.9 mm, with a 98.2 mm anterior breadth of the sacrum. It has an anterior height of 111.5 mm and a posterior length from the base to the apex of 140.5 mm. There is a failure of fusion of laminae of the 4<sup>th</sup> vertebra, while the spinous process of the 3<sup>rd</sup> is partially formed. An agenesis of the dorsal wall of the sacral canal in the level of the 2<sup>nd</sup> to 3<sup>rd</sup> vertebrae 24.7 mm in length, alongside with two smaller apertures (right and left) in the level of the



**Figure 1.** The sacrum, anterior view (A) and posterior view (B); \*Aperture of the sacrum.



**Figure 2.** The sacrum, lateral view, the aperture in the sagittal plane; \*Aperture of the sacrum.

1<sup>st</sup>–2<sup>nd</sup> with a diameter of approximately 5.1 mm each, cause a longer sacral hiatus, an abnormal sacral canal and a deformed median sacral crest (Fig. 1). The right aperture had a distance of 2.5 mm from the midline, 3.6 cm from the sacrum base and 4.7 cm from the middle of the right auricular surface. Respectively, the left aperture was located 4 mm from the midline, 3.7 cm from the sacrum base and 4.5 cm from the middle of the left auricular surface. However, the most peculiar bony variation is this of a round aperture formed in the sagittal plane between the 1<sup>st</sup> and the 2<sup>nd</sup> spinous process. This aperture has an inner diameter of 10.8 mm with an outer one of 28.3 mm and was located 2.2 cm from the

sacrum base and 5.8 cm from its top (Fig. 2), exactly at the median line of the dorsal surface of the sacrum.

The sacral promontory had a normal form and pattern. Four pairs of pelvic sacral foramina at the pelvic surface and four pairs of dorsal sacral foramina at the dorsal surface were observed as expected. The dorsal sacral foramina were placed lateral to the fused laminae and at each side of the aperture described above. Auricular surface, attachments of interosseous sacroiliac ligaments and transverse ridges presented no variations.

## DISCUSSION

The variations in the canal and spinous process of the sacrum in current case description most belong

to a series of alternations known as midline birth defects [5]. Smaller apertures as the ones we describe in each side of the bone have been reported at the literature [2]. However, the discovered in our case aperture between the 1<sup>st</sup> and the 2<sup>nd</sup> vertebrae needs more discussion. Although as a variation is located in the midline, implying an abnormal pattern during embryological life, an ossification of the supraspinous ligament is also possible.

The supraspinous ligament is a strong fibrous cord like entity, which connects apices of spinous process from C7 to sacrum. Several times, at the points of attachment to the tips of the bone, fibrocartilage is developed in the ligaments leading eventually to ossification or calcification, a rather common phenomenon. It is triggered by genetic factors, or when the ligaments sustain an unusual increased tension, torn or involved in lesions of vertebral bone or joints due to trauma [8]. It seems that fibroblasts and/or chondrocyte-like cells respond to this external stimulus and form an irregular network of fine fibrils producing acid mucopolysaccharide. They eventually undergo a calcification process alongside with a capillary invasion, being transformed into osteoblasts and causing a progressive calcification [3]. This ectopic new bone accretion in supraspinous ligament may create a cord like bony formation along the line between the spinous process [8]. In our case as only the 1<sup>st</sup> and the 2<sup>nd</sup> spinous process are fully formed. Thus, this is the only area where the supraspinous ligament may truly be attached and form after its ossification such an aperture.

This “open door” like round shaped opening does not qualify by definition as a foramen, as it is rather impossible to operate as a conduit for vessels and nerves [7]. It seems that should be simply nominated as an aperture, merely an opening formed locally. Although the variations of the dorsal wall of the sacral canal present a great significance in neurology and local anaesthesia through the sacral hiatus, the round aperture looks like having no importance. However, it may cause a low back pain, discomfort and stiffness, or may be a sign of ankylosing spondylitis [6]. Lupus or rheumatoid arthritis might also be the cause of the supraspinous ligament ossification. Chronic diseases of the sacrum, such as Paget disease, Sacrum Pott’s disease (spine tuberculosis), cancer or osteoporosis do not seem to be related to this irregular bone morphology as they are osteolytic diseases.

Other congenital abnormalities of the sacrum might be sacral agenesis, butterfly vertebrae, anterior or posterior spina bifida and abrupt termination of the sacrum [9]. These conditions might cause neurogenic lower limb anomalies, sensory sparing and urologic problems. In the case presented we believe that such complications might not happen as the aperture does not seem to serve as a foramen for nerves [9].

## CONCLUSIONS

Whatever the case may be, abnormal ossification or ossification/calcification of the supraspinous ligament, our case depicts a unique image of a sacrum with a peculiar aperture. Any variation in skeletal anatomy could create a difficulty for healthcare professionals in their daily practice.

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