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Study of morphometry of sacrum

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ABSTRACT

The sacrum is one of the parts of the vertebral column which is formed by the fusion of five sacral vertebrae. It lies between the two hip bones contributing to the formation of the pelvic girdle. It helps in transmitting the body weight of the lower limb and supports the erect spine by providing strength and stability to the bony pelvis. It articulates superiorly with the fifth lumbar vertebra to form the lumbosacral joint and inferiorly with the coccyx to form sacrococcygeal joint. The study of morphometry of sacrum is important clinically as well as from the forensic point of view.

Keywords: Forensic, Morphometry, Pelvic Girdle,Sacrum

INTRODUCTION

The vertebral column is the bony pillar of the body which supports the skull, pectoral girdle, upper limb and the thoracic cage whereas the pelvic girdle transmits the body weight of the lower limb. The vertebrae are the structures which help in the formation of the vertebral column. There are 33 numbers of vertebrae in the human body which forms the vertebral column. They are 7 number of cervical vertebra, thoracic 12 in number, lumbar 5 in number, the sacrum formed by 5 fused sacral vertebra and coccyx formed by 3-5 number of fused vertebra. The length of the vertebral column in males is about 70 cms and in females is about 60 cms. The vertebral column helps in protecting the spinal cord with its covering and the spinal nerves.

Structure

The sacrum is one of the parts of the vertebral column. It is a large triangular bone formed by the fusion of five sacral vertebrae, which is placed between the two hip bones.[1]It helps in the formation of the pelvic girdle. [1] It helps in transmitting the body weight of the lower limb and also supports the erect spine by providing strength and stability to the bony pelvis.[2] The name Sacrum is derived from the Latin word *sacer*which means Sacred, as it is thought to be the only bone preserved after burning of a witch.[3]

The Sacrum is wedge shaped having a base, apex, four surfaces, pelvic (vertebral), dorsal, 2 lateral surfaces and a canal called the sacral canal, which is the continuation of the vertebral canal and terminates at the Sacral Hiatus. It also forms an angle with the rest of the vertebral column,i.e. sacro-vertebral angle or the lumbosacral angle. The base is divided into a central portion –the promontory which articulates with the fifth lumbar vertebra to form Lumbosacral Joint. The either side of the promontory is known as ala, which is formed by the fusion of the transverse process and the costal part of the primitive vertebra. Apex of the Sacrum is formed by the 5th Sacral Vertebra which articulates with the coccyx.

The ventral or the pelvic surface is smooth and concave both vertically and transversely and presents four transverse ridges which represent the fused intervertebral disc. It also has four pairs of pelvic sacral foramina which transmit Ventral rami of upper 4 sacral nerves anda branch from the lateral sacral artery.

The dorsal surface is raised and irregular, presents the median Sacral crest, Intermediate and Lateral sacral crest

with spinous tubercles, which represents the remnant of fused Sacral Spines. The Intermediate Sacral crests are formed by the fusion of the articular processes. The lateral sacral crests are formed by the fusion of the transverse processes. There are four pairs of dorsal sacral foramina lying lateral to the Intermediate Sacral Crest.The lateral surfaces are wider above and narrower below, articulate with the ilium to form Sacroiliac Joint. The anterior and posterior margins of the articular surface give attachment to the ventral and dorsal Sacroiliac Ligaments.[4]

The sacral canal is formed by the sacral vertebra foramina, which are triangular in shape. The sacral hiatus is an opening at the posteroinferior part of the sacral canal, formed as a result of the non-union of the lamina of the 5th sacral vertebra.[5] The contents of the sacral canal are the lower part of the CaudaEquina, Filumterminale, Spinal meninges and the lateral sacral vessels.

Muscles

The ventral or pelvic surface gives attachment to Piriformis muscle in 2nd to 4th segments, iliacus muscle superolaterally and to the coccygeus muscle inferolaterally. The dorsal surface of the sacrum gives attachment to the aponeurosis of the erector spinae along a U shaped area of the spines and the transverse tubercles, covering the multifidus muscle. The lateral border below the articular surface of the sacrum gives attachment to the gluteus maximus posteriorly and the coccygeus anterior to the sacrotuberous and sacrospinous ligaments.[4]

Blood supply and lymphatics

Sacrum is supplied by the median sacral artery (a branch of abdominal aorta) and two lateral sacral arteries (branches of posterior division of the internal iliac artery). Sacral veins drain into the venous plexuses, located both inside and outside the vertebral canal. Lymph nodes are located in the concavity of the sacrum and receive lymphatic flow from the rectum and posterior pelvic wall.[6]

Nerves

The five pairs of sacral spinal nerves (S1-S5) originate from the caudaequina. S1-S4 exit from the ventral sacral foramina and S5 from the sacral hiatus.[6]

Embryology

Sacrum is developed from the fusion of five mesodermal somites. In the 4th embryonic week, 42-44 pairs of somites appear from the paraxial mesoderm. Not consistently, it develops from the 31st to 35thsomites, each of which is divided into the sclerotome, myotome, and dermatome.[3] The ossification of the sacrum resembles that of a typical vertebra. The primary centers of the body and each half of the vertebral arch appear between the 10th and 20th week.[4] Sacrum ossifies from 21 primary and 14 secondary centres. The primary centres are present in the bodies, arches and costal elements, whereas secondary centres are present in the epiphysis of the bodies, auricular surfaces and margins below the auricular surfaces. Primary centers appear by 2-8 months of intrauterine life and fuse by 2-8 years. Secondary centers appear by puberty and fuse by 25 years.[7]

Sexual dimorphism

The length of sacrum is more in males than females. The anterior surface of male sacrum is shallower than female sacrum. The female sacrum is wider than male sacrum. The male sacrum is uniformly curved, whereas female sacrum is flattened in the upper part but sharply curved in the lower part.[7] The auricular surfaces are relatively smaller and more oblique in females than males.[4] Sacral Index is <1 in male and = or >1 in female. It is the ratio between the length and breadth of the sacrum and is expressed by the formula, Breadth x 100/ length.[8]The lumbosacral angle varies between 128^0 and 160^0 with an average of 140^0 in the males and 137^0 in the females.[8]

Variations

Morphological variants:[9]

i. Sacral Defects

These can be

a. Sacral agenesis (Absent Vertebra)
b. Dysgenesis-Hemi sacrum (Hemi Vertebra)
c. Sacral Spina Bifida with meningocele or myelomeningocele (Deficiency of Neural Arch)
d. Presence of sacral rib[6]

Physiological variants:[6]

i. Presence of lumbosacral transitional vertebrae (LSTV)

a. At the level of L5- sacralization
b. At the level of S1- lumbarization

Anatomical variants: [1]

There can be variations in the anatomical features of the sacral hiatus in shape, sacral composition, level of apex of sacral hiatus, level of the base of haitus, alteration in the curvature of the sacrum.

Clinical significance

1. Fracture of sacrum may occur as a part of pelvic fracture.[10]
2. Sacrum can be the site for primary sarcomas. It can be a secondary site for the metastasis of cancer from the pelvis via venous plexuses around the vertebral column.[6]
3. Sacral hiatus is the site for epidural anesthesia in conditions of lumbar spinal injuries and severe lower backache.[5]
4. In forensic anthropology, the sacrum has important role in determination of the sex.[11]
5. Knowledge of type of variation will be helpful for radiologist in interpreting the radiograph of sacral spine, which will benefit the orthopedicians in diagnosing the cause of low backache.[1]

Fig 1[4]: Sacrum (Superior Aspect)

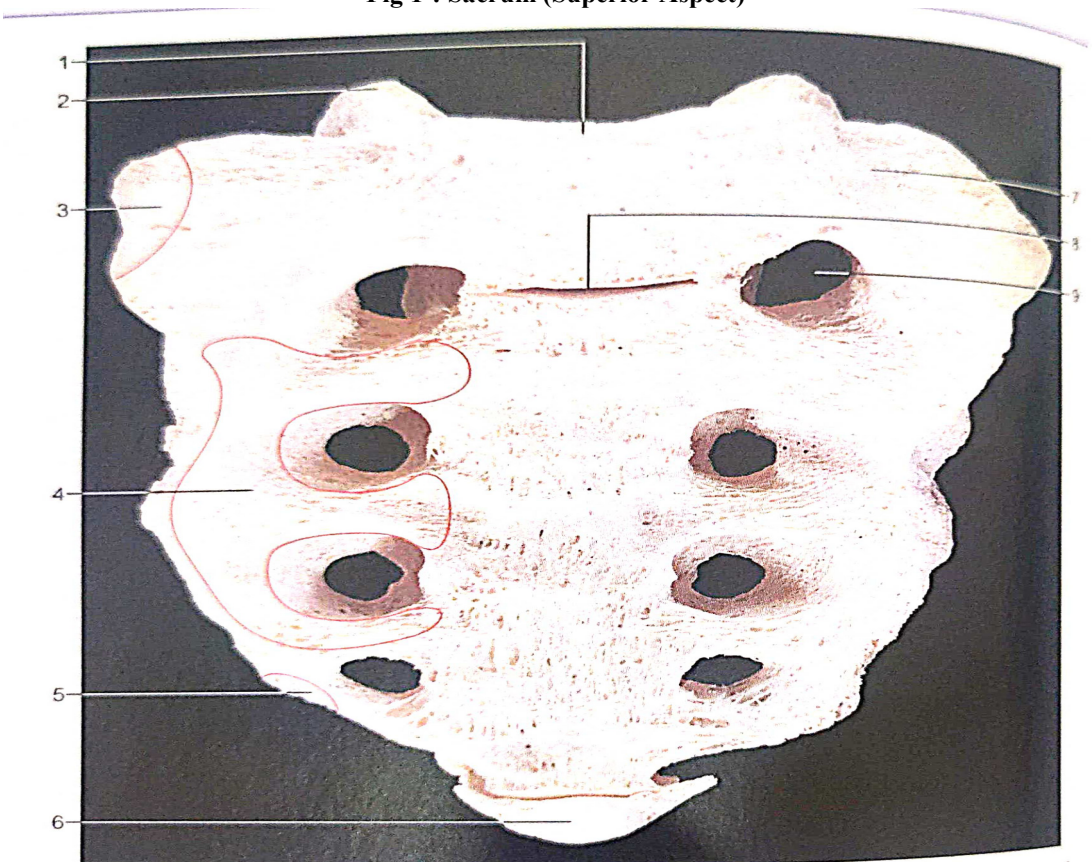

Fig 2[4]: Sacrum (Pelvic/ Ventral Surface)

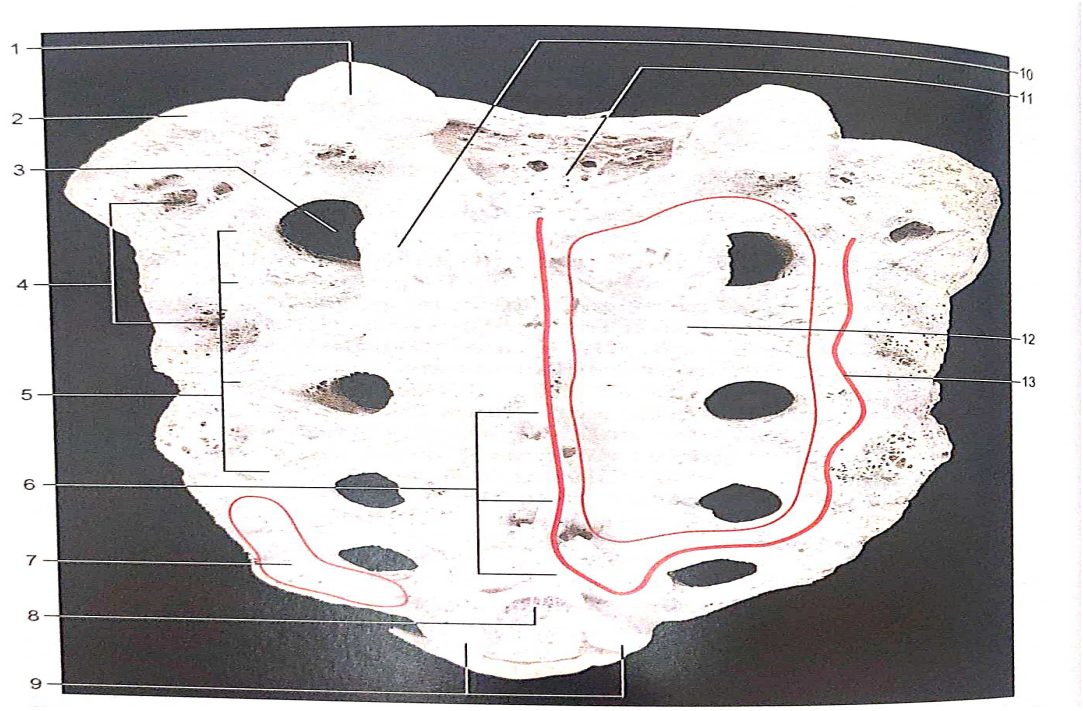

Fig 3[4]: Sacrum (Dorsal Surface)

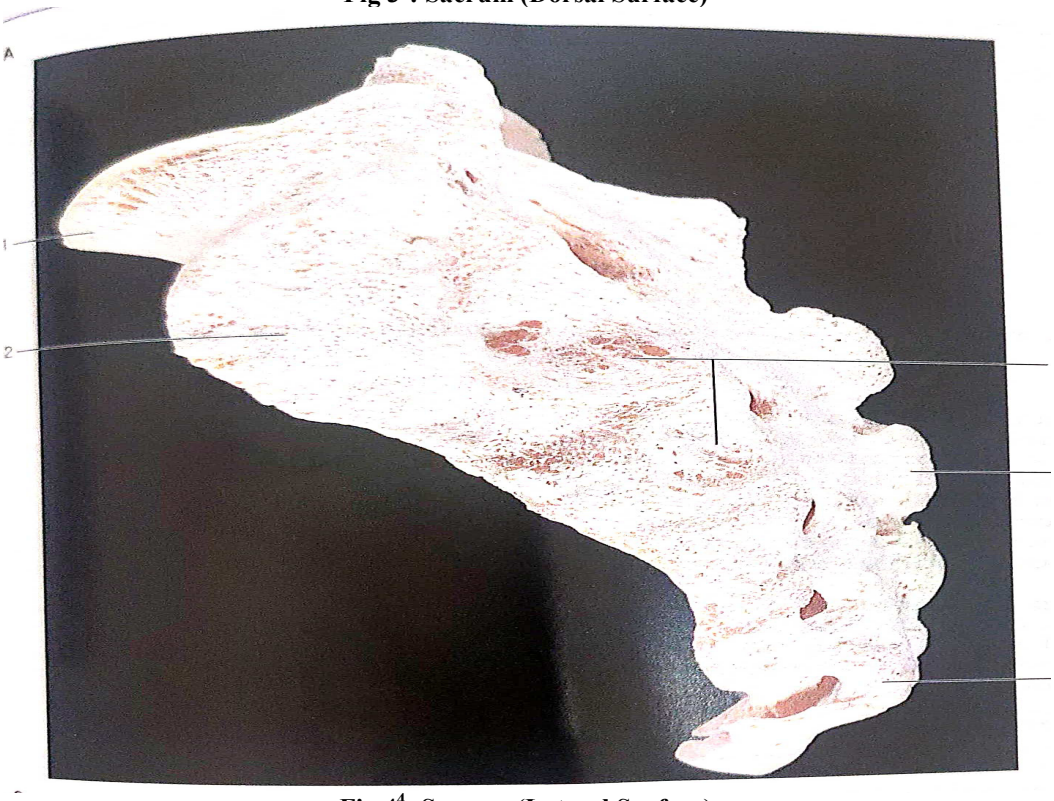

Fig 4[4]: Sacrum (Lateral Surface)

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