# Surgical Anatomy of the Sacrum

# 21

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The sacrum is a triangular bony structure which is fused together with five sacral vertebrae. The sacrum articulates with the ilium, the fifth vertebra, and the coccyx, forming the posterior wall of the bony pelvis. It was oblique to the spine, with the anterior surface being concave, which increases pelvic capacity to contain the pelvic organ. The lateral surfaces of the sacrum form the joint surfaces, which are articulated with the posterior inner parts of the ileum. It has a base, three surfaces, and an apex.

**Base**. The base of the sacrum, which has a similar shape to that of the lower surface of the fifth lumbar vertebral body, is oval in shape. It is the upper surface of the first sacrum. The anterior edge is termed the sacral promontory. The pedicles of the sacra are short and divergent posterolaterally to join with the laminae. The laminae incline backwards and medially and then meet in the midline and form the spinous tubercle. The upper part of the sacrum articulates with the fifth lumbar vertebra by the intervertebral disc and the facet joints, which form by the superior articular processes of the sacrum and the inferior articular processes of the fifth lumbar vertebra. The transverse process is a broad bony structure, sloping and projecting laterally away from the sacral body and the pedicle. It consists of transverse process and costal element, forming the superior part of the sacral ala.

**The surfaces of the sacrum**. The ventral surface of the sacrum is concave and the dorsal surface is convex. Four pairs of sacral foramina communicate through intervertebral foramina with the sacral canal, transmitting ventral rami of the upper four sacral spinal nerves. The large area between the right and left foramina formed by flat pelvic aspects of the sacral bodies shows their fusion by four transverse ridges. Bars between foramina are costal elements fused to the vertebrae. Lateral to the foramina, the costal elements unite together and posteriorly with transverse processes to form the ala of the sacrum. The pelvic surface gives attachment to the piriformes. The first three sacral ventral rami emerge from the pelvic sacral foramina and then pass anteriorly to piriformis to join in the sciatic nerve and the pudendal nerve. The sympathetic trunks descend medially to the sacral foramina; and the median sacral vessels descend in the midline, which lie in direct contact with the ventral surface of the sacrum. The lateral sacral vessels pass through laterally to the sacral foramina. The parietal peritoneum covers the ventral surfaces of the first three sacral bodies; and the rest of the ventral surface of the sacral vertebrae is in contact with the rectum. The superior rectal artery, which serves the distal part of the rectum, bifurcates at the level of the third sacral vertebra.

The dorsal surface of the sacrum was convex and irregular. A raised median sacral crest, with four spinous tubercles, runs down in the middle line. The median sacral crest stops at the sacral hiatus, approximately at the level of the fourth spinous tubercle, where the dorsal surface of the fifth vertebral body is exposed. The posterior surface of the sacrum is constituted by fused laminae. Lateral to the median crest lie four pairs of dorsal sacral foramina, which communicate with the sacral canal through intervertebral foramina. The dorsal rami of sacral nerves transmit through the sacral foramina. The intermediate sacral crests lie medially to the foramina, which are two rows of small tubercles, representing the fused articular processes. The lateral sacral crests, formed by fused transverse processes, lie laterally to the dorsal sacral foramina. The erector spinae attaches to the elongated U-shaped area between the median and lateral sacral crest; the sacral spinal dorsal rami serve these muscles as they emerge from dorsal foramina.

The lateral surface, which is wide above and narrow in its lower part, is a fusion area of transverse processes and the residual costae. It articulates with the ileum with an auricular surface in the inferior and anterior part and a rough and deeply pitted superior and posterior part for the attachment of ligaments between the sacrum and ileum. The auricular surface occupies the upper lateral surface from the first sacral vertebra to the middle of the third of the sacral vertebra.

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Inferior to the auricular surface, the sacrum reduces in breadth and curves medially to the body of the fifth sacral vertebra.

The auricular area of the sacrum is covered by hyaline cartilage. The auricular area has elevations and depressions to increase the contact surface of the joint, so as to increase the stability of the rigid joint. The rough area is superior and posterior to the auricular surface, which has two or three depressions for attachment of the interosseous sacroiliac ligaments. The gluteus maximus and the sacrotuberous and sacrospinous ligaments attach to the lateral side of the sacrum below the auricular surface; and anterior to these structures, the piriformes attach to the pelvic surface and lateral side of the sacrum.

**Sacral apex**. The apex is the distal end of the fifth sacral vertebral body. The oval surface of the apex articulates with the coccyx.

**Sacral canal**. The sacral canal is triangular in transverse plane, communicating from the fifth vertebral foramina to the hiatus. It is formed by sacral vertebral foramina. Owing to the sacral inclination, its upper opening is oblique when standing. In the lateral wall lies four intervertebral foramina, which communicate with pelvic and dorsal sacral foramina.

The sacral canal accommodates the sacral dural sac, cauda equina, and filum terminale. Approximately at the end of the second sacrum, the sacral dural sac ceases. The sacral spinal roots and filum terminale pierce the arachnoid and dura maters and pass through the sacral canal and the intervertebral foramina, forming the ventral rami or dorsal rami. The fifth sacral nerves, the coccygeal nerve, and the filum terminale emerge from the sacral hiatus to innervate the coccygeal region.

**Sex differences in sacra**. Generally, the female sacrum is shorter and wide, producing a wider pelvic cavity. Sacral width, as a percentage of length, yields a sacral index. The ventral concavity is deeper in females, and its deepest point is usually higher than in males; curvature above this point is greater in the female. The dorsal protrusion of the second sacral vertebra is therefore usually less prominent in males. In females the pelvic surface faces downwards more than in males, increasing the pelvic cavity and making the lumbosacral angle more prominent. In the male, the first sacral body occupies a larger proportion of the sacral base, for the fifth lumbar body is usually large and the pelvis is relatively narrow. The transverse diameter exceeds the length of an ala, while the diameter of the sacral base is roughly equal to that of the ala.

**Variations**. The fifth lumbar or first coccygeal vertebrae may incorporate with the sacrum, which results in five pairs of intervertebral foramina on both the ventral and dorsal surfaces. The incorporation of the fifth lumbar (sacralization of the lumbar spine) is usually at one side, or even only an enlarged transverse process of the fifth lumbar spine articulates with the sacrum at the posterolateral aspect of the ala. Lumbarization of the first sacral vertebra occurs, but relatively rare. The development of laminae and spines may be incomplete, resulting in the deficiency of the posterior aspect of the sacral canal.

**Attachments of the first sacral body**. The anterior longitudinal ligament attaches to the middle portion of the anterior surface of the sacrum till to the coccyx. The terminal fibres of the posterior longitudinal ligaments attach to the anterior wall of the sacral canal. Upper laminar borders of the sacrum receive the lowest part of the ligamenta flava, which attaches to the bony structure of the posterior wall of spinal canal. The lumbosacral trunk obliquely grooves the smooth area of the superior part of the ala. The lower band of the iliolumbar ligament attaches to the rough area of the lateral side of the ala. The whole ala is covered mostly by the psoas major. Iliacus reaches the anterolateral part of this area.

**Sacroiliac joint and the surrounding ligaments**. The sacroiliac joint is a rigid weight-bearing joint, formed by ear-shaped auricular surfaces of the sacrum and the ilium and posterior syndesmoses. The auricular surfaces are smooth but with elevations and depressions. The auricular surfaces interlock with each other, allowing the joint a limited mobility. Syndesmoses are quite strong, facilitating the transmission of body weight to the lower limb. Several strong ligaments around the sacroiliac joints improve the stability of it. The anterior sacroiliac ligaments are broad and thin layers of fibrous capsule, which exists only in the superior parts of the joints. The interosseous sacroiliac ligaments, lying between the rough area of the sacrum and ilium posterior to the auricular surface, are the major structures that support body weight of the upper part. The posterior sacroiliac ligaments, which are the superficial parts of the syndesmosis, run upwards and downwards from the lateral crest of sacrum to the posterior parts of ilium and the sacrotuberous ligament (Fig. 21.1).

**The ligaments connecting the sacrum and the spine**. Sacro-lumbar ligaments are strong triangular ligaments, which connect the fifth transverse process and the iliac crest. The sacrotuberous ligament attaches broadly to the long oblique area of the posterior superior iliac crest, the lower transverse sacral tubercles, and the lateral margins of the lower sacrum and the upper coccyx. Its fibres, which are partly blended with the posterior sacroiliac ligaments, converging and descending laterally, attach to the ischial tuberosity's medial margin. Sacrospinous ligaments are thin and triangular in shape. Lying deeply to the sacrotuberous ligament, it attaches to the lateral margins of the sacrum and coccyx and extends to the ischial spine. The pudendal nerve and internal pudendal vessels, lying anteriorly to the piri-

formis, leave the pelvis and curve around the dorsal aspect of the ischial spine and then re-enter the internal pelvic wall by the lesser sciatic foramen. From the posterior view, the sacrospinous ligaments lie deeply to the sacrotuberous ligaments. Two ligaments stabilize the sacrum on the pelvis and prevent the tilting of it. The greater and lesser sciatic foramens, which are divided by sacrotuberous and sacrospinous ligaments from the sciatic notch region, are the entrances and exits of muscles, vessels, and nerves (Figs. 21.1 and 21.2).

**The sacroccygeal joint**. The apex of the sacrum and the base of the coccyx join with each other, forming the sacrococcygeal joint. It is strengthened by sacrococcygeal ligaments anteriorly and posteriorly.

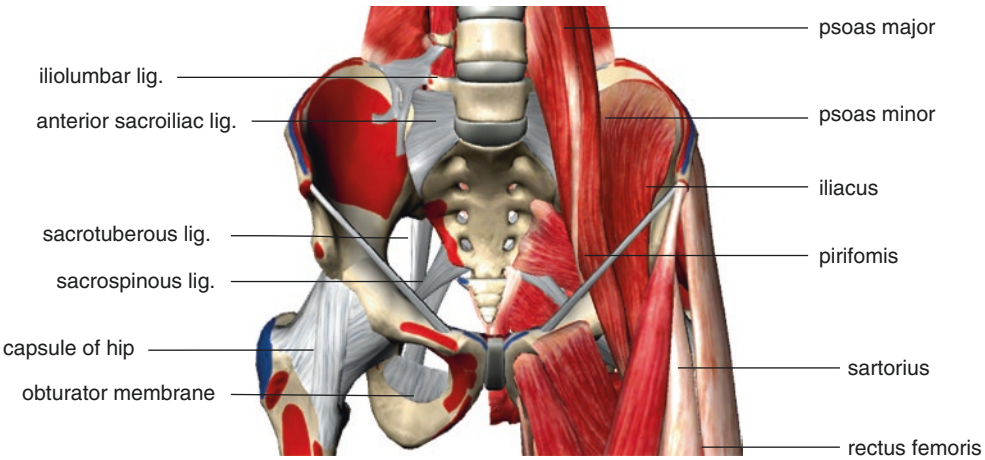


**Fig. 21.1** The ligaments and muscles around the pelvis and the sacrum (anterior view)

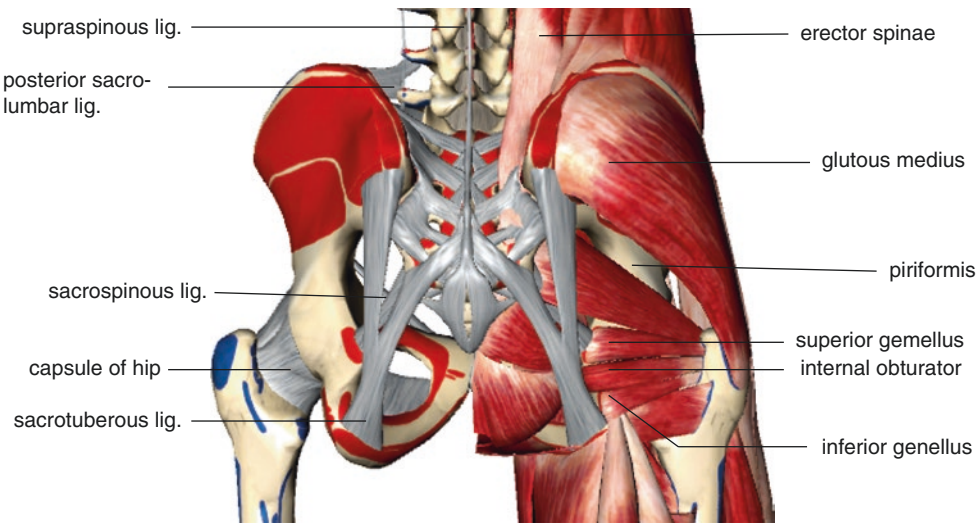


**Fig. 21.2** The ligaments and muscles around the pelvis and the sacrum (posterior view)