

Anatomy of the pelvis

Vishy Mahadevan

Abstract

The term pelvis as used in this article denotes the irregular but complete bony ring made up of the right and left hip bones (*ossa coxae*) anteriorly and at the sides, and by the sacrococcygeal part of the vertebral column, posteriorly. It is massively constructed. The two hip bones are firmly united anteriorly at the pubic symphysis, and together constitute the pelvic girdle. The pelvic girdle articulates with the femoral heads and thereby connects the vertebral column (axial skeleton) to the two femora (appendicular skeleton). The main functions of the pelvic girdle are to transmit weight from the upper body to the lower limbs during locomotion and while standing, and to support the weight of the upper body when seated or stationary. Another important function of the bony pelvis is to provide attachment for the powerful muscles (e.g. gluteal muscles) that act on the lower limb and those muscles that support the abdominal wall. The bony pelvis also provides ample protection to the many delicate viscera, vessels and nerves that lie within the pelvic cavity. Fractures of the bony pelvis are relatively uncommon injuries. Most pelvic fractures are caused by high-energy traumatic events such as forceful collisions in road traffic accidents or major crush injuries as may be caused by falling masonry. Successful orthopaedic management of disruptions of the bony pelvis and management of associated injuries to intrapelvic viscera require a sound appreciation of the anatomy of the pelvic ring and pelvic cavity.

Keywords Pelvic brim; pelvic girdle; pelvic ligaments; pelvic viscera; pubic symphysis; sacroiliac joints

Structure of the bony pelvis (Figure 1)

The term pelvis is often used interchangeably to signify: (a) the bony ring formed by the two hip (innominate) bones and the sacrococcygeal part of the vertebral column; (b) the cavity enclosed by the above-mentioned bony ring; and (c) the entire region where the lower part of the trunk meets the lower limbs.

Such casual, imprecise and careless use of the term 'pelvis' is often both confusing and annoying to the reader.

This author favours precision in the use of terminology and recommends strongly, that the term 'pelvis' be reserved for the bony pelvic ring and its associated stabilizing ligaments, and the term 'pelvic cavity' be used to denote the space that lies within the bony ring, below the level of the pelvic brim and above the pelvic floor.

The bony pelvis refers to the irregular but complete bony ring formed by the right and left hip bones at the front and sides, and by the entire sacrococcygeal part of the vertebral column, posteriorly (Figure 1). Externally, on each side, the bony pelvis articulates with the corresponding femoral head to form the hip

joint. Superiorly, through the lumbosacral articulation the bony pelvis supports the vertebral column. The bony pelvis includes four articulations, as follows. The two hip bones are held together anteriorly at the pubic symphysis; an extremely strong and virtually unbreachable bond. Posterolaterally, on either side, the medial aspect of the hip bone articulates with the corresponding lateral aspect of the sacrum to form a synovial joint, the sacroiliac joint. Finally, the inferior end of the sacrum articulates with the upper surface of the coccyx to form the sacrococcygeal joint. The pubic symphysis and the sacrococcygeal articulation are both examples of **secondary cartilaginous joints**.

On each side the hip bone presents a curved ledge, the iliac crest which marks the upper border of the hip bone. The iliac crest is often visible in the lean individual, and readily palpable in all subjects. The anterior and posterior extremities of the iliac crest are the anterior superior iliac spine and posterior superior iliac spine, respectively (Figures 1 and 2).

In the normal, upright individual the bony pelvis has a pronounced and permanent forward tilt to such a degree that the anterior superior iliac spines and the upper edge of the pubic symphysis are in the same vertical plane while the ischial spines, the upper edge of the pubic symphysis and the tip of the coccyx are in the same horizontal plane (Figure 1).

The inner aspect of the bony pelvis features a somewhat undulant (wavy), more-or-less complete bony ridge termed the pelvic brim. By convention the plane of the pelvic brim is used to divide the bony pelvis into two parts: the part below the level of the pelvic brim is the lesser pelvis (or true pelvis) and the part above the pelvic brim is the greater pelvis (or false pelvis). The area enclosed by the lesser pelvis is the pelvic cavity, whereas the area enclosed by the greater pelvis (i.e. above the pelvic brim) is in fact the lower part of the abdominal cavity and includes the right and left iliac fossae (Figure 1). Owing to the forward tilt of the articulated pelvis described above, the plane of the pelvic brim is oblique, lying at 60 degrees to the horizontal (Figure 1).

The pelvic brim, which defines the upper limit of the pelvic cavity, is made up of the sacral promontory (the prominent anterior lip of the upper surface of the body of the sacrum), posteriorly, and is formed on either side by the arcuate line of the ilium and superior ramus of the pubis, while anteriorly it is made up of the pubic crest and the upper edge of the pubic symphysis (Figure 1).

On each side of the midline, the bony pelvis below the level of the pelvic brim, presents three 'gateways' – namely the greater sciatic foramen, lesser sciatic foramen (Figures 2 and 3) and obturator foramen (Figure 1). Through these gateways the interior of the bony pelvis connects with areas outside the pelvic ring. Located posterolaterally are the greater sciatic foramen and lesser sciatic foramen which allow the interior of the bony pelvis to communicate with the ipsilateral gluteal region. Located anterolaterally is the obturator foramen, through which the interior of the pelvis communicates with the adductor region of the thigh. The obturator foramen is a large opening in the anterior part of the hip bone, and has a complete bony boundary (Figure 1). In life it is almost completely closed by a dense and strong fibrous sheet termed the obturator membrane.

Each hip bone is developmentally a composite of three bones: pubis, ischium and ilium. These three bones meet and fuse at a

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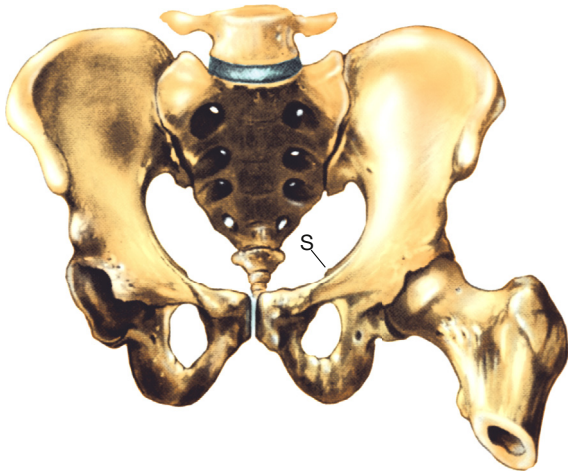


Figure 1 The pelvic ring viewed from the front

Y-shaped epiphysis (the triradiate cartilage) which lies partially within the acetabulum (the cup-shaped hollow on the lateral aspect of the hip bone which accommodates the head of the femur). Complete ossification of the acetabular triradiate cartilage occurs by the 18th year of life.

The bony pelvis serves multiple functions:

- It transmits the weight of the upper part of the body to the lower limbs through the hip joints, and transmits to the vertebral column the upward thrust generated by the lower limbs during walking, running and jumping.
- The bony pelvis offers considerable protection to the delicate viscera and vessels contained within it.
- Its external surface provides anchorage to several extremely powerful muscles such as the gluteal muscles

and muscles of the thigh including the adductors and hamstrings.

Pelvic joints and ligaments (Figures 2 and 3)

The joints of the pelvis are the right and left sacroiliac joints, the pubic symphysis and the sacrococcygeal joint. The stability of these pelvic joints is, in turn, dependent on powerful ligaments. The principal pelvic ligaments are the sacrotuberous, sacrospinous, iliolumbar, anterior sacroiliac, posterior sacroiliac and interosseous sacroiliac ligaments.

The **sacroiliac joint** is a synovial joint of the plane variety, between the opposed auricular surfaces of the ilium and sacrum. The capsule of the joint lined internally by synovial membrane is attached to the articular margins of both bones. In adults (particularly in males) numerous thick fibrous bands pass between the sacral and iliac auricular surfaces obliterating the joint cavity in places. The sacroiliac joint is reinforced on its anterior aspect by the ventral sacroiliac ligament, and on its dorsal aspect by the dense and very strong interosseous sacroiliac ligament and more superficially by the dorsal sacroiliac ligament.

The **pubic symphysis** is a secondary cartilaginous joint between the bodies of the right and left pubic bones. The opposed surfaces of the two pubic bones are each covered by a thin plate of hyaline cartilage. A dense and strong band of fibrous tissue joins the two hyaline cartilage covered surfaces. Reinforcing ligamentous fibres on the superior and inferior aspects of the symphysis pubis are called the superior pubic ligament and arcuate pubic ligament respectively.

The **sacrococcygeal joint** is a secondary cartilaginous joint (symphysis) between the narrow inferior extremity of the sacrum and the superior surface (i.e. base) of the coccyx (Figure 1). The sacrococcygeal joint is reinforced on its anterior aspect by the

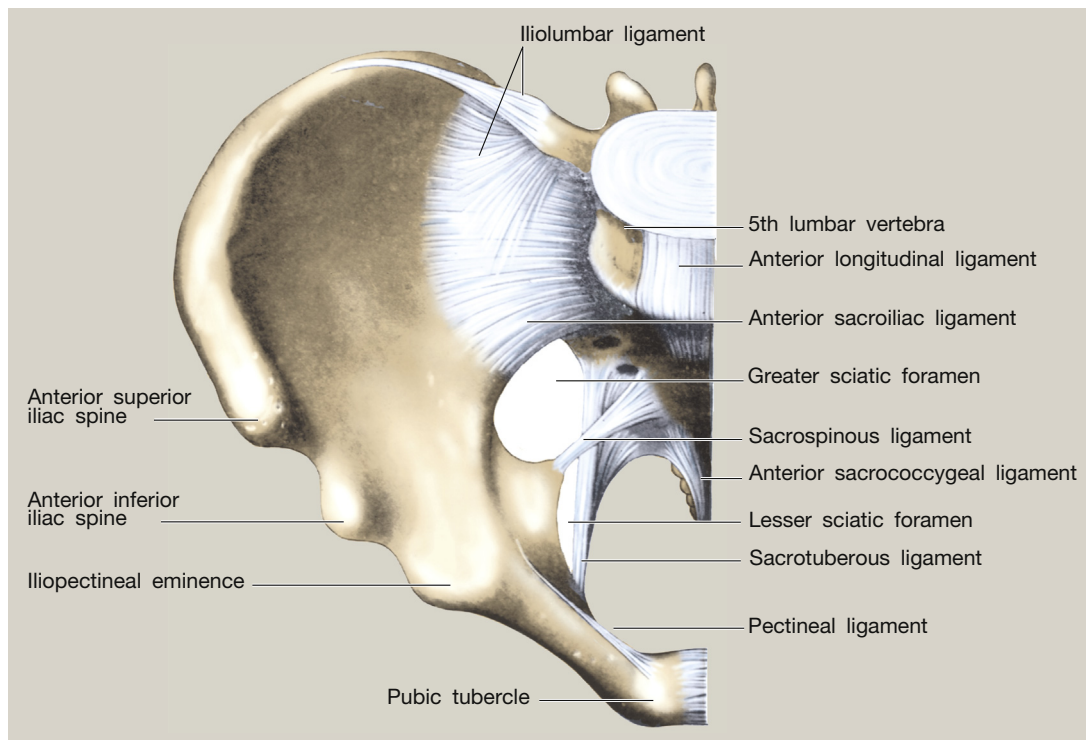


Figure 2 Right half of pelvic ring with associated ligaments (anterior view)

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