

Anatomy of the anterior abdominal wall and groin

Vishy Mahadevan

Abstract

This article describes, in a systematic manner, the anatomy of the anterior abdominal wall, with emphasis being placed on clinical and surgical aspects. This knowledge should help the reader understand the anatomical basis to various laparotomy incisions. Also described in this article is the anatomy of the inguinal canal and inguinal herniae and the anatomical distinction between direct and indirect inguinal herniae.

Keywords anterolateral abdominal muscles; inguinal canal; inguinal herniae; rectus sheath

The outline of the anterior abdominal wall is approximately hexagonal. It is bounded superiorly by the arched costal margin (with the xiphisternal junction at the summit of the arch). The lateral boundary on either side is, arbitrarily, the mid-axillary line (between the lateral part of the costal margin and the summit of the iliac crest). Inferiorly, on each side, the anterior abdominal wall is bounded in continuity, by the anterior half of the iliac crest, inguinal ligament, pubic crest and pubic symphysis.

Layers of the anterior abdominal wall

The anterior abdominal wall is a many-layered structure (Figure 1). From the surface inwards, the successive layers are:

- skin
- superficial fascia (comprising two layers)
- a musculo-aponeurotic 'plane' (which is architecturally complex and composed of several laminae).
- transversalis fascia
- a preperitoneal adipose layer
- parietal peritoneum.

Skin: the skin covering the anterior abdominal wall is thin compared with that of the back, and is relatively mobile over the underlying layers except at the umbilical region, where it is fixed. Natural elastic traction lines of the skin (also known as skin tension lines or Kraissl's lines) of the anterior abdominal wall are disposed transversely. Above the level of the umbilicus these tension lines run almost horizontally, while below this level they run with a slight inferomedial obliquity. Incisions made along, or parallel to, these lines tend to heal without much scarring, whereas incisions that cut across these lines tend to result in wide or heaped-up scars.

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The superficial fascia: comprises two distinct layers.

- An outer, adipose layer immediately subjacent to the dermis and similar to superficial fascia elsewhere in the body. This layer is also sometimes referred to as Camper's fascia.
- An inner fibroelastic layer termed Scarpa's fascia (the membranous layer of superficial fascia). Scarpa's fascia is more prominent and better defined in the lower half of the anterior abdominal wall. Also, it is more prominent in children (particularly infants) than in adults.

Superiorly, Scarpa's fascia crosses superficial to the costal margin and becomes continuous with the retromammary fascia. Laterally it fades out at the mid-axillary line. Inferiorly, it crosses superficial to the inguinal ligament and blends with the deep fascia of the thigh about 1 cm distal to the inguinal ligament. Below the level of the pubic symphysis, in the male, Scarpa's fascia is prolonged quite distinctly into the scrotum and around the penile shaft. This prolongation of Scarpa's fascia into the perineum is known as the superficial perineal fascia or Colles' fascia. A similar, but less distinct and less readily demonstrable extension of Scarpa's fascia occurs in the female perineum. As in the male this extension is known as superficial perineal fascia.

Musculo-aponeurotic 'plane' (Figures 1 and 2):

The rectus abdominis – is a long, strap-like muscle one on either side of the vertical midline. Each muscle arises by two tendons; a lateral tendon from the pubic crest, and a medial tendon from the upper and anterior surfaces of the pubic symphysis. The two tendons unite a short distance above the pubis to give rise to a single muscle belly which runs upwards to attach to the anterior surfaces of the seventh, sixth and fifth costal cartilages. The upper part of the muscle usually shows three transverse tendinous intersections; one at the level of the umbilicus, one at the level of the xiphoid tip and one halfway between the two (Figures 1a and 2).

On either side of the rectus abdominis, the musculo-aponeurotic plane is made up of a three-ply (overlapping) arrangement of flat muscular sheets. The outermost of these is the external oblique muscle, the innermost is the transversus abdominis muscle and the intermediate layer is the internal oblique muscle. Of these, only the external oblique has an attachment above the level of the costal margin. Followed anteromedially, each of these muscles becomes aponeurotic. These aponeuroses, between them, enclose the rectus abdominis muscle; the envelope is termed the rectus sheath.

The external oblique muscle – arises by fleshy digitations from the outer aspect of each of the lower eight ribs near their costochondral junctions (Figure 2). From this origin the muscle fibres fan downwards and forwards. The fibres that arise from the lower two ribs run downwards to insert onto the anterior half of the outer lip of the iliac crest; the posterior edge of this mass of fibres constitutes the free posterior border of the muscle. The remainder of the muscle ends in a broad aponeurosis. The lower edge of this aponeurosis extends between the anterior superior iliac spine and the pubic tubercle. It is rolled inwards to form a narrow and shallow gutter, and constitutes the inguinal ligament. The fascia lata (deep fascia of the thigh) attaches to the distal surface of the inguinal ligament. The rest of the external oblique aponeurosis runs in front of the rectus abdominis muscle

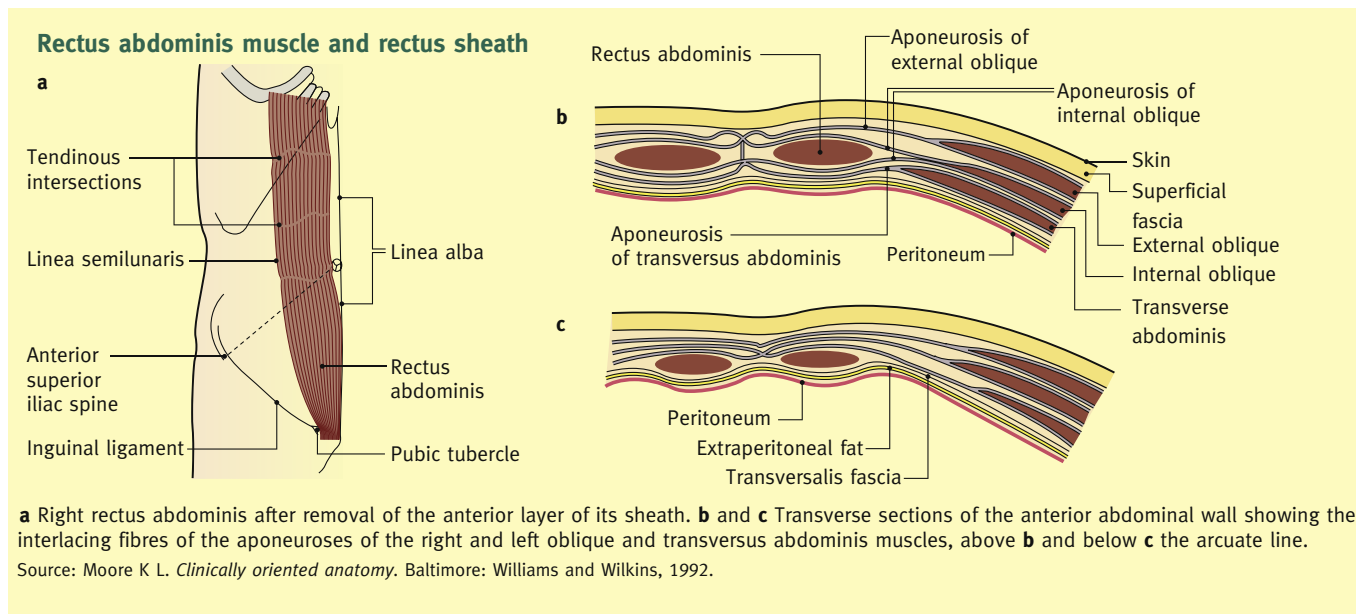


Figure 1

of its side and interdigitates with the contralateral aponeurosis along the vertical midline. Below the level of the xiphoid process this interdigitation helps to form a raphe, the linea alba (Figure 1).

The internal oblique muscle – lies immediately deep to the external oblique. It arises, in continuity, from the lateral two-thirds of the guttered inguinal ligament, from a central strip along the anterior two-thirds of the iliac crest, and from the

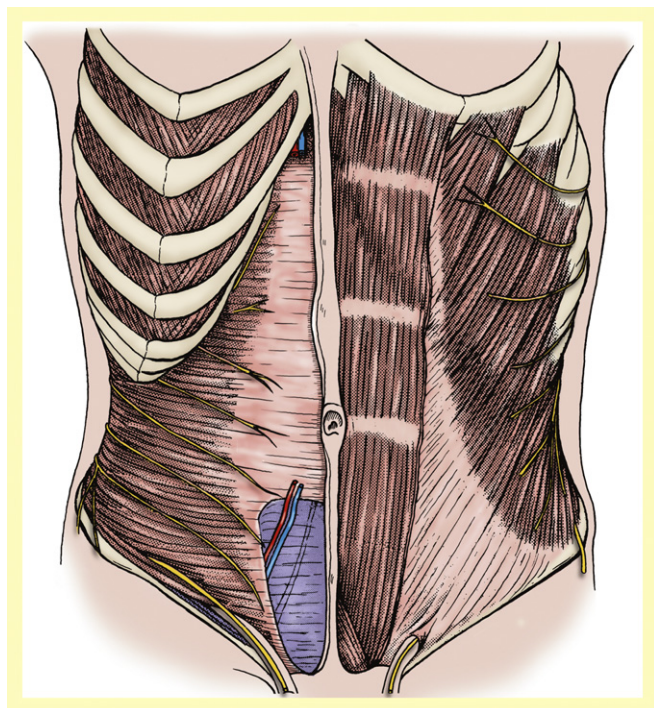


Figure 2 Anterior and anterolateral muscles of the abdominal wall (the rectus and pyramidalis muscles have been removed on the right side to reveal the posterior wall of rectus sheath and the epigastric vessels).

lateral margin of the lumbar fascia along the lateral border of the quadratus lumborum muscle (a muscle of the posterior abdominal wall). The muscle fibres arising from the lumbar fascia run upwards to attach along the length of the costal margin. The remainder of the muscle fibres run upwards and medially from their origin, becoming aponeurotic lateral to the outer border of the rectus abdominis. At the outer edge of the latter, the aponeurosis of the internal oblique splits into two laminae (anterior and posterior), which run medially, respectively, in front of, and behind the rectus abdominis muscle, to interdigitate with their counterparts in the vertical midline, at the linea alba. The anterior lamina of the internal oblique is thus immediately deep to the external oblique aponeurosis. The posterior lamina running behind the rectus abdominis muscle is immediately in front of the transversus abdominis aponeurosis, down to the arcuate line (see below: rectus sheath).

Transversus abdominis – arises in continuity from the lateral half of the guttered surface of the inguinal ligament (immediately deep to the origin of the internal oblique), from the inner lip of the anterior two-thirds of the iliac crest, from the lateral margin of the lumbar fascia and from the inner surfaces of the cartilages of the lower six ribs. From this origin, the muscle fibres run forwards and medially, closely applied to the inner surface of the internal oblique. The fibres become aponeurotic at the lateral edge of the rectus abdominis, and the aponeurosis continues medially behind the posterior lamina of the internal oblique aponeurosis (and therefore behind the rectus abdominis) to meet its counterpart at the linea alba. A few finger-breadths below the level of the umbilicus, however, the aponeuroses of all three muscles run in front of rectus abdominis (see below: rectus sheath) (Figures 1c and 2).

The linea alba (Figures 1 and 2) – is a longitudinally disposed, midline interdigitation of the aponeuroses of the three-ply muscles (external oblique, internal oblique and transversus abdominis) of one side with those of the other side. The linea alba extends from the xiphoid process above, to the pubic

symphysis below. Lying between the medial edges of the recti, the linea alba is a pale band of fibro-aponeurotic tissue, considerably wider and thicker above the level of the umbilicus than below. In some individuals the linea alba may become weak through abnormal attenuation and widening, thereby allowing exaggerated lateral deviation of the two rectus sheaths whenever intra-abdominal pressure is raised. This condition is termed divarication of recti.

The rectus sheath (Figure 1b and c) – is the aponeurotic envelope that ensheathes the rectus abdominis muscle. Thus, the rectus sheath may be said to possess an anterior wall and a posterior wall. The anterior wall of the rectus sheath is composed of two adherent layers; a superficial layer made up of the external oblique aponeurosis and a deep layer made up of the anterior lamina of the internal oblique aponeurosis. The posterior wall of the rectus sheath is, likewise, composed of two adherent layers. The anterior layer of the posterior wall is the posterior lamina of the internal oblique aponeurosis, while the posterior layer is the transversus abdominis aponeurosis. This arrangement holds true only from the level of the costal margin down to a level about 5–6 cm below the umbilicus. Below this level, all three aponeuroses run in front of the rectus abdominis muscle, with the result that below this level, there is no aponeurotic posterior wall to the rectus sheath. This abrupt change in the relationship of the aponeuroses to the rectus abdominis, results in the posterior wall of the rectus sheath having a sharp, free border, a short distance below the level of the umbilicus (Figure 2). This border is called the arcuate line. Thus, below the arcuate line the posterior surface of the rectus abdominis muscle is in direct relationship to the fascia transversalis.

Above the level of the costal margin, the rectus abdominis is covered on its anterior surface only, by the external oblique aponeurosis alone. The transverse tendinous intersections in the rectus abdominis muscle blend with the anterior wall of the rectus sheath.

Innervation and blood supply of the muscles of the anterior abdominal wall (Figure 2)

The muscles of the anterior abdominal wall are supplied segmentally by the seventh to 11th intercostal nerves and the subcostal nerve. These nerves (accompanied by their corresponding posterior intercostal vessels) cross the costal margin obliquely to run in the neurovascular plane of the anterior abdominal wall, between the internal oblique and transversus abdominis muscles. The nerves supply these muscles and divide into lateral and anterior branches. The former penetrate the overlying internal oblique to supply the external oblique muscle, while the anterior branches run medially, before entering the rectus abdominis through its posterior surface. Having supplied the muscles, these nerve branches eventually supply the overlying skin. Cutaneous innervation of the anterior abdominal wall by the seventh to 11th intercostal nerves and subcostal nerve is represented by a series of oblique band-shaped dermatomes. The dermatome corresponding to the 10th intercostal nerve is at the level of the umbilicus; that of the seventh intercostal nerve is at the epigastric level. The 11th intercostal and subcostal nerves supply strips of skin below the umbilical level, while the

iliohypogastric nerve (L1) and the ilioinguinal nerve (also L1) supply a strip of skin immediately above the inguinal ligament and pubic symphysis.

Because there is considerable overlap in the dermal territories of adjacent cutaneous nerves, damage to one or two of these nerves will usually not produce detectable anaesthesia.

The posterior intercostal arteries (which accompany the intercostal nerves) supply the three-ply muscles in the lateral part of the anterior abdominal wall, and in this function are reinforced by the lumbar arteries, which are branches of the abdominal aorta.

The rectus abdominis has a different blood supply. The upper half of the muscle is supplied by the superior epigastric artery (a branch of the internal thoracic artery). The artery enters the rectus abdominis alongside the xiphisternal junction with its companion veins. The lower half of the rectus abdominis is supplied by the inferior epigastric artery, a branch of the external iliac artery.

Myocutaneous rotation flaps may be fashioned using the upper or lower halves of the rectus abdominis muscle; the former being based on the superior epigastric vascular pedicle and the latter being based on the inferior epigastric vascular pedicle.

Transversalis fascia: the transversalis fascia is the anterior part of the general endo-abdominal fibrous layer that envelops the peritoneum. It is thicker and less expansile in the lower part of the anterior abdominal wall. The transversalis fascia is closely applied to the deep surface of the transversus abdominis muscle but is easily separable from the latter.

Properitoneal adipose layer: the properitoneal adipose layer (also known as fascia propria) is interposed between the transversalis fascia and the parietal peritoneum. This layer offers little resistance to the spread of infection and, consequently, cellulitis secondary to surgical wound infections may spread rapidly within it.

Inguinal region

The groin or inguinal region denotes the area adjoining the junctional crease between the front of the thigh and the lower part of the anterior abdominal wall, and includes the inguinal and femoral canals.

The inguinal canal (Figure 3): is an obliquely placed slit-like space within the lower part of the anterior abdominal wall. It may be represented on the surface by a 1.5 cm-wide band, above and parallel to the medial half of the inguinal ligament. The inguinal canal starts laterally at the deep (internal) inguinal ring (a defect in the fascia transversalis), and runs downwards and medially to open at the superficial (external) inguinal ring (a triangular defect in the external oblique aponeurosis). In adults, the inguinal canal is about 5–6 cm long. In males, the inguinal canal contains the spermatic cord and the ilioinguinal nerve; in females, it contains the round ligament of the uterus and the ilioinguinal nerve. Another nerve which runs within the inguinal canal is the genital branch of the genitofemoral nerve. This slender nerve enters the inguinal canal through the deep inguinal ring. In the male, it travels as a constituent of the

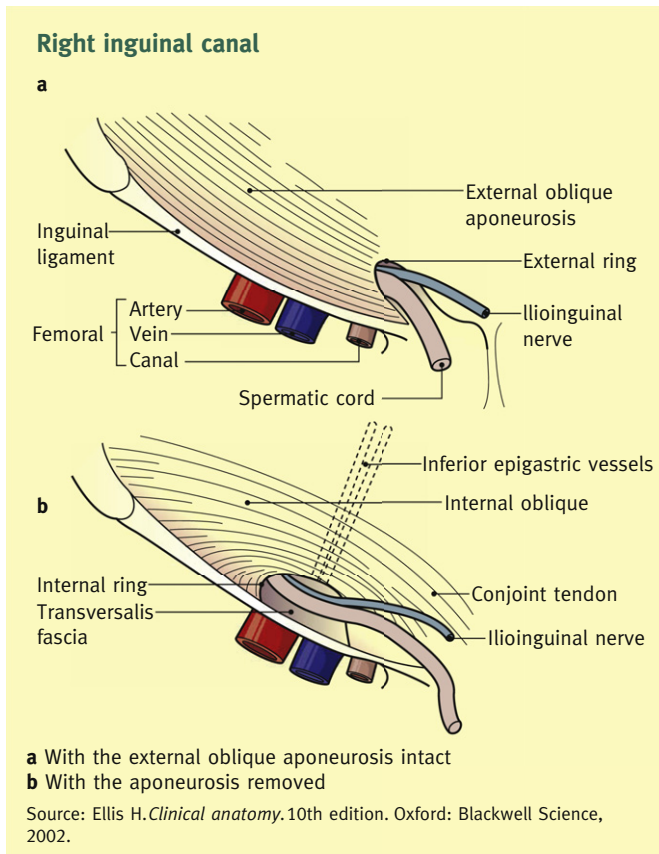


Figure 3

spermatic cord and innervates the cremaster muscle. It also provides sensory innervation to the coverings of the spermatic cord. In the female, the nerve runs alongside the round ligament of the uterus and emerges at the superficial inguinal ring to supply vulval skin. The ilioinguinal and genitofemoral nerves are branches of the lumbar plexus.

The inguinal canal consists of a floor, a roof, an anterior wall and a posterior wall. The floor of the inguinal canal is the upper surface of the in-rolled inguinal ligament; the floor being completed medially by the upper surface of the lacunar ligament (a curved extension of the medial end of the inguinal ligament). The anterior wall of the inguinal canal is the external oblique aponeurosis, reinforced on the lateral part of its inner surface by those fibres of internal oblique which arise from the inguinal ligament. The roof of the canal is formed by those fibres of internal oblique and transversus abdominis which, originating from the inguinal ligament, run superomedially arching above the spermatic cord (or round ligament), before fusing to form the conjoint tendon.

The posterior wall of the inguinal canal is the fascia transversalis, reinforced on its anterior surface medially by the conjoint tendon. The deep inguinal ring is thus a natural defect in the posterior wall of the canal, while the superficial ring is a natural defect in the anterior wall.

Running obliquely in a superomedial direction behind the posterior wall of the inguinal canal, medial to the deep inguinal ring, are the inferior epigastric vessels.

Inguinal hernia: is an abnormal protrusion of the peritoneal cavity into the inguinal canal. When this protrusion enters the inguinal canal through the deep inguinal ring, it is termed an 'indirect inguinal hernia'. Such a hernia has the potential to enlarge and emerge through the superficial inguinal ring and, in men, the hernia may enter the scrotum. The neck of an indirect inguinal hernia sac lies in the deep inguinal ring and thus is situated lateral to the inferior epigastric artery. When the peritoneum protrudes into the inguinal canal, medial to the inferior epigastric artery, through an attenuated and weakened posterior wall, it is termed a 'direct inguinal hernia'. The neck of a direct hernial sac is therefore medial to the inferior epigastric artery. Occasionally, an inguinal hernia may possess two sacs, one direct and the other indirect. Such a hernia is termed a pantaloon hernia. ◆