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THE ABDOMINAL WALL, UMBILICUS, PERITONEUM, MESENTERIES, OMENTUM, AND RETROPERITONEUM

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ABDOMINAL WALL

The abdominal wall is a complex musculoaponeurotic structure attached to the vertebral column posteriorly, the ribs superiorly, and the bones of the pelvis inferiorly. It is derived embryonically in a segmental, metameric fashion, and this is reflected in its blood supply and innervation.

The abdominal wall protects and restrains the abdominal viscera, and its musculature acts indirectly to flex the vertebral column. The integrity of the abdominal wall is essential to the prevention of hernias, whether congenital, acquired, or iatrogenic. Additionally, the abdominal wall is the repository of the panniculus adiposus, which may reach considerable proportions in patients with morbid obesity.

Embryology

The abdominal wall develops quite early in the embryo but does not achieve definitive structure until the umbilical cord separates from the fetus at birth. Most of the abdominal wall forms during closure of the midgut and reduction in relative size of the body stalk. The primitive wall is somatopleure (ectoderm and mesoderm without muscle, blood vessels, or nerves). The somatopleure of the abdomen is secondarily invaded by mesoderm from the myotomes that developed on either side of the vertebral column. This mesodermal mass (hypomere) migrates ventrally and laterally as a sheet and the leading edges differentiate, while still widely separated from each other, into the right and left rectus abdominis muscles. The final apposition of these muscles in the anterior midline closes the body wall (Fig. 1).

Before the primordia of the rectus muscles fuse anteriorly, the mesoderm from the hypomere splits into three layers which can be recognized by the seventh week of development. The inner sheet differentiates into the transversus abdominis muscle; the middle sheet becomes the internal oblique muscle; and the superficial sheet becomes the external oblique muscle and its aponeurosis. Dorsally, the superior and inferior posterior serratus muscles develop from the superficial layer of the hypomere.

Approximation of the two rectus abdominis muscles in the midline proceeds from both cranial and caudal ends and is complete by the twelfth week except at the umbilicus. The final closure of the umbilical ring awaits the separation of the cord at birth, but the ring may remain open, in which case an umbilical hernia will be present. Most such hernias will gradually close spontaneously.

Anatomy, Innervation, and Lymphatic Drainage

The abdominal wall is composed of nine layers: (1) skin, (2) tela subcutanea (subcutaneous tissue), (3) superficial fascia (Scarpa's fascia), (4) external abdominal oblique muscle, (5) internal abdominal oblique muscle, (6) transversus abdominis muscle, (7) endoabdominal (transversalis) fascia, (8) extraperitoneal adipose and areolar tissue, and (9) peritoneum.

The *skin* of the abdomen may be involved in generalized dermatoses but is usually otherwise unremarkable. It is rarely the site of cutaneous neoplasia because it usually is protected from exposure to the sun. The *tela subcutanea* contains a layer of soft adipose tissue that generally increases with age. It contains little fibrous connective tissue and affords little strength in closure of abdominal incisions. This layer rests upon the superficial fascia (Scarpa's), which is not to be confused with the investing fascia of the abdominal wall muscles. *Scarpa's fascia* is a layer of fibrous connective tissue of modest thickness and contains abundant adipose tissue. A discrete layer of the fascia can ordinarily be demonstrated in the lower abdominal wall, and the layer may be confused with

THE ANTERIOR BODY WALL

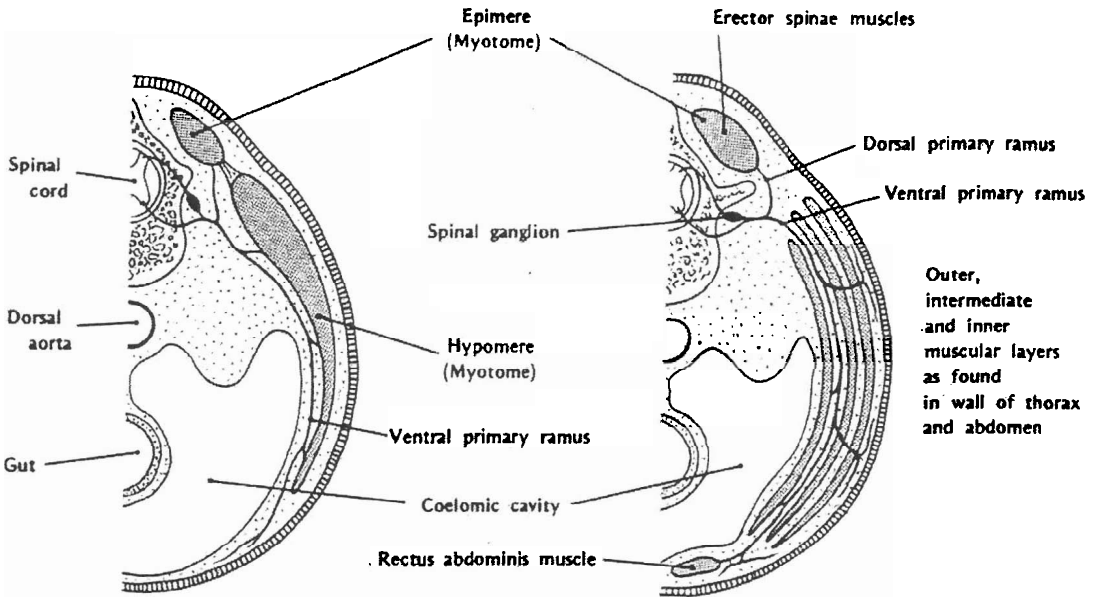

Figure 1. Schematic diagram showing the establishment of the primordia of the abdominal wall muscles. On the left, the relationship of the myotomes to the primitive central nervous system and coelomic cavity is shown. On the right, the differentiation of the hypomere to form the three layers of the abdominal wall musculature is depicted. (Modified from Langman, J.: Medical Embryology. Baltimore, The Williams & Wilkins Company, 1969.)

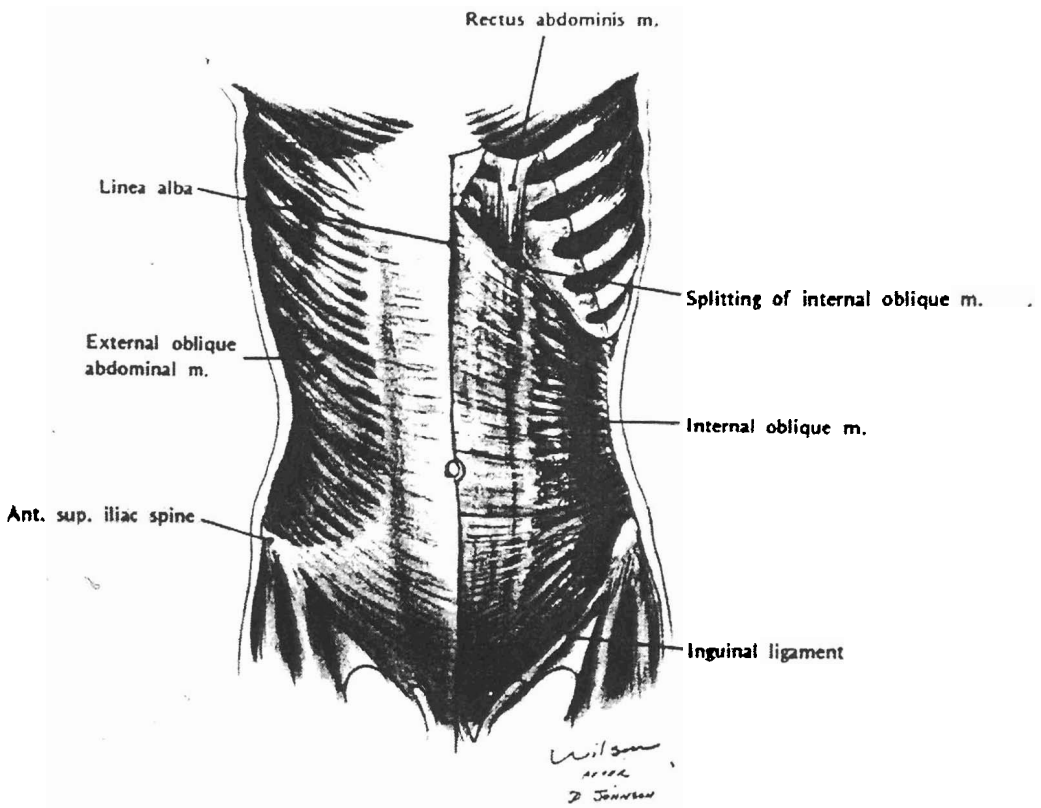

Figure 2. Schematic diagram of abdominal wall muscles showing the external oblique and the internal oblique abdominal muscles. The rectus muscles are seen near the midline. The right rectus muscle is covered by the rectus sheath. (Modified from Healey, J. E., Jr.: *A Synopsis of Clinical Anatomy*. Philadelphia, W. B. Saunders Company, 1969.)

the aponeurosis of the external oblique muscle by inexperienced surgeons. The layer affords little strength in wound closure, but its approximation aids considerably in the creation of an aesthetic, hairline scar.

The *muscular abdominal wall* is composed of three flat muscles with broad origins. The muscular wall encloses the largest fraction of the circumference of the torso. Anteriorly the three flat muscles give way to flat aponeuroses that fuse to form the investing fascia (sheath) of the rectus abdominis muscles.

The *external abdominal oblique muscle* (paired right and left) is the largest of the flat abdominal muscles and is also the thickest. Its broad origin includes the last seven ribs, the thoracolumbar fascia (lumbodorsal aponeurosis), the external lip of the iliac crest, and the inguinal ligament which inserts into the pubic tubercle. The muscle belly gives way to a flat, strong aponeurosis at about the midclavicular line, and it inserts medially into the linea alba (Fig. 2). Strictly speaking, the aponeurosis of the external oblique passes anterior to the sheath of the rectus abdominis and, with care, can be dissected from it. In general, the fascicles of the external oblique muscle pass from superior-lateral to inferior-medial. Thus, the direction of force generated by contraction of muscle is superior-lateral.

The *internal abdominal oblique muscle* originates from the last five ribs, the thoracolumbar fascia, the intermediate lip of the iliac crest, and the lateral half of the inguinal ligament. Its fibers run in the opposite direction to those of the external oblique. The internal oblique also gives way to a flat aponeurosis medially which splits to enclose the rectus muscle. The aponeurosis reunites medial to the rectus and inserts into the linea alba (Fig. 3). The fibers arising from the lateral half of the inguinal ligament pursue a downward course and insert into the os pubis between the symphysis and the tubercle. Some of the lower fibers of the internal oblique muscle descend into the scrotum with the testis as it passes through the abdominal wall. These latter fibers are called the cremasteric muscle of the spermatic cord. The cremasteric muscle is responsible for a superficial reflex of the same name, in which the testis is retracted from the scrotum in the direction of the inguinal canal.

The *transversus abdominis muscle* is the smallest of the three flat muscles of the abdomen. It originates from the lower five ribs, the thoracolumbar fascia, the internal lip of the iliac crest, and the lateral one third of the inguinal ligament. Its fibers run in a transverse direction, and they give way to a flat aponeurosis that inserts into the linea alba. The aponeurosis passes behind the rectus sheath in its upper two thirds. The fibers of the transversus abdominis originating from the inguinal ligament pass downward to insert into the os pubis, as do the fibers of the internal oblique muscle. Occasionally, the lower fibers of both muscles insert by means of a common tendon called the conjoint tendon (Fig. 4). A true conjoint tendon probably occurs infrequently. More often, the muscles insert into the os pubis as a "conjoint muscle."

The plane between the internal oblique and the transversus abdominis muscles can properly be considered a neurovascular plane because it contains the segmental arteries, veins, and nerves that supply the abdominal wall. The anterior primary rami of thoracic spinal nerves T7–T12 and lumbar nerve L1 supply the abdominal wall in a segmental, sequential manner from above downward. The main trunks of the nerves are found in the neurovascular plane. The anterior cutaneous rami pierce the rectus sheath anteriorly to supply the anterior skin. The anterior cutaneous rami of T10 innervate a dermatome that includes the umbilicus. The lateral cutaneous rami of T7–9 supply the skin of the thorax and lateral abdominal wall, and the lateral cutaneous rami of T12 and L1 supply the skin of the gluteal region.

The *transversalis fascia* is poorly named and often misunderstood. It more properly should be called the endoabdominal fascia, since it is a continuous lining of the abdominal cavity. When this fascia lies in direct relation to certain muscles, as over the psoas muscle, it is called the psoas fascia; when deep to the transversus abdominis muscle, it is termed the transversalis fascia. The integrity of the endoabdominal fascia is essential for the integrity of the abdominal wall. If this layer is intact, no hernia exists. A hernia can be defined as a hole in the endoabdominal fascia or transversalis fascia, and this definition applies to esophageal hiatus hernia, umbilical hernia, inguinal hernia, femoral hernia, and incisional hernia.

The transversalis fascia contains a thickened band, the iliopubic tract, which lies deep to the inguinal ligament. Like the inguinal ligament, the iliopubic tract extends from the anterior-superior spine of the iliac crest to the pubic tubercle. The iliopubic tract is of considerable importance in the repair of groin hernias.

The *extraperitoneal adipose* and *connective tissue* layer of the abdominal wall is surgically relatively unimportant. It is found between the endoabdominal fascia and the peritoneum. It contains a greater amount of adipose tissue in obese persons. It also contains the remains of four fetal structures and the inferior epigastric arteries and veins. The latter vessels course from the external iliac vessels upward and medial to the rectus sheath, where they supply the rectus abdominis muscle from below (Fig. 5). The obliterated umbilical arteries arise from the superior vesical arteries and course upward to the umbilicus. They produce a fold of peritoneum (visible from the inside of the peritoneal cavity) called the medial umbilical ligaments, which are paired right and left. In the midline, the obliterated urachus passes from the apex of the bladder to the umbilicus. It is a fibrous cord that represents the remnant of the allantoic stalk. Like the obliterated umbilical arteries, the obliterated urachus also raises a peritoneal fold, the median umbilical ligament.

Above the umbilicus in the midline, the extraperitoneal adipose tissue projects deep between the two leaves of the falciform ligament of the liver. In the free margin of this sickle-shaped ligament lies the ligamentum teres hepatis (the obliterated umbilical vein), which courses from the umbilicus

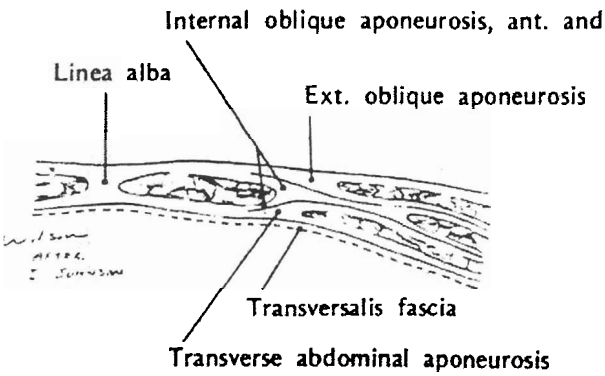

Figure 3. Schematic diagram of transverse section of upper abdominal wall muscles near the umbilicus. The aponeurosis of the internal oblique muscle splits to invest the rectus abdominis muscle. (Modified from Healey, J. E., Jr.: *A Synopsis of Clinical Anatomy*. Philadelphia, W. B. Saunders Company, 1969.)