

INTRODUCTION

Hernia repair is one of the commonest procedures performed by general surgeons; indeed, it has been stated that ‘the history of hernia repair is the history of surgery. The most common technique for inguinal hernia repair was originally an open, tissue-based suture repair, which eventually evolved to commonly use prosthetics (with various fixation devices of sutures, staples, tacks, and glue) for a tension-free repair with a significantly lower recurrence rate (**Basile F, et al 2013**) and lower chronic pain after surgery (**Simons MP, et al 2009**).

Laparoscopic repair of the inguinal hernia is becoming an increasingly popular method of herniorrhaphy. The advent of laparoscopy has revolutionized abdominal surgery and a large body of evidence has been amassed to compare laparoscopic and open techniques in the repair of primary inguinal hernias (**Memon MA, et al 2003**). Advantages of laparoscopic procedures may include a reduction in postoperative pain and hospital stay, and the ability to undertake a simultaneous repair of symptomatic incipient contralateral herniation. However, open repair can be performed under local anesthesia and is preferred by many surgeons. (**Kehlet H, et al 2005**)

The repair of recurrent inguinal hernia is a more complex undertaking, accounting for up to 15 per cent of all hernia surgeries (**Neumayer L, et al 2004**). Since the use of prosthetic mesh for the surgical repair of inguinal hernias has become increasingly popular, mesh material introduced during a previous operation is being detected in a growing number of patients undergoing surgery for recurrent hernia. This applies to at least 10% of recurrences. (**Breuing K, et al 2010**)

Recurrent hernias greatly increase the complexity of subsequent repair. If left untreated, severe complications can result such as incarcerated hernia, digestive obstruction, or strangulated hernia. Highly complex abdominal surgery is often required to repair recurrent hernias. Success rates are generally lower for each re-operation.

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AIM OF THE WORK

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Chapter 1

ANATOMY

There are nine layers to the abdominal wall-skin, subcutaneous tissue, superficial fascia, external oblique muscle, internal oblique muscle, transversus abdominis muscle, transversalis fascia, preperitoneal adipose and areolar tissue, and peritoneum.

Subcutaneous Tissues

The subcutaneous tissue consists of Camper's and Scarpa's fascia. Camper's fascia is the more superficial adipose layer that contains the bulk of the subcutaneous fat, whereas Scarpa's fascia is a deeper denser layer of fibrous connective tissue continuous with the fascia lata of the thigh. Approximation of Scarpa's fascia aids in the alignment of the skin after surgical incisions in the lower abdomen. (*Thorek P. 1962*)

The Linea Alba

The linea alba is a tendinous raphé in the middle line of the abdomen, stretching between the xiphoid process and the symphysis pubis. It is placed between the medial borders of the Recti, and is formed by the blending of the aponeuroses of the

Obliqui and Transversi. It is narrow below, corresponding to the linear interval existing between the Recti; but broader above, where these muscles diverge from one another. At its lower end the linea alba has a double attachment—its superficial fibers passing in front of the medial heads of the Recti to the symphysis pubis, while its deeper fibers form a triangular lamella, attached behind the Recti to the posterior lip of the crest of the pubis, and named the *adminiculum linear albae*. It presents apertures for the passage of vessels and nerves; the umbilicus, which in the fetus exists as an aperture and transmits the umbilical vessels, is closed in the adult. (*Allan J. 2010*)

Muscle and Investing Fascias

The muscles of the anterolateral abdominal wall include the external and internal oblique and transversus abdominis. These flat muscles enclose much of the circumference of the torso and give rise anteriorly to a broad flat aponeurosis investing the rectus abdominis muscles, termed the *rectus sheath*. The external oblique muscles are the largest and thickest of the flat abdominal wall muscles. (*McVay C 1984*)

They originate from the lower seven ribs and course in a superolateral to inferomedial direction. The most posterior of

the fibers run vertically downward to insert into the anterior half of the iliac crest. At the midclavicular line, the muscle fibers give rise to a flat strong aponeurosis that passes anteriorly to the rectus sheath to insert medially into the linea alba. The lower portion of the external oblique aponeurosis is rolled posteriorly and superiorly on itself to form a groove on which the spermatic cord lies. (**Rath AM et al. 1996**)

This portion of the external oblique aponeurosis extends from the anterior superior iliac spine to the pubic tubercle and is termed the *inguinal* or *Poupart's ligament*. The inguinal ligament is the lower free edge of the external oblique aponeurosis posterior to which pass the femoral artery, vein, and nerve and the iliacus, psoas major, and pectineus muscles. A femoral hernia passes posterior to the inguinal ligament, whereas an inguinal hernia passes anterior and superior to this ligament. (**Johnson TG et al., 2014**)

The shelving edge of the inguinal ligament is used in various repairs of inguinal hernia, including the Bassini and the lichenstein tension-free repair. (**Robinson A et al., 2013**)

The internal oblique muscle originates from the iliopsoas fascia beneath the lateral half of the inguinal ligament, from the. Anterior two thirds of the iliac crest and lumbodorsal

fascia. Its fibers course in a direction opposite To those of the external oblique—that is, inferolateral to superomedial. The uppermost fibers insert into the lower five ribs and their cartilages. The central fibers form an aponeurosis at the semilunar line, which, above the semicircular line (of Douglas), is divided into anterior and posterior lamellae that envelop the rectus abdominis muscle. (*Tran D et al., 2014*)

Below the semicircular line, the aponeurosis of the internal oblique muscle courses anteriorly to the rectus abdominis muscle as part of the anterior rectus sheath. (*Montgomery A et al., 2013*)

The lowermost fibers of the internal oblique muscle pursue an inferomedial course, paralleling that of the spermatic cord, to insert between the symphysis pubis and pubic tubercle. Some of the lower muscle fascicles accompany the spermatic cord into the scrotum as the cremasteric muscle. (*Moore et al., 2006*)

The transversus abdominis muscle is the smallest of the muscles of the anterolateral abdominal wall. It arises from the lower six costal cartilages, spines of the lumbar vertebra, iliac crest, and iliopsoas fascia beneath the lateral third of the inguinal ligament. (*Jones CM et al., 2016*)

The fibers course transversely to give rise to a flat aponeurotic sheet that passes posterior to the rectus abdominis muscle above the semicircular line and anterior to the muscle below it. The inferior most fibers of the transversus abdominis originating from the iliopsoas fascia pass inferomedially along with the lower fibers of the internal oblique muscle. These fibers form the aponeurotic arch of the transversus abdominis Muscle, which lies superior to Hesselbach's triangle and is an important anatomic landmark in the repair of inguinal hernias, particularly Bassini's operation and Cooper's ligament repairs. Hesselbach's triangle is the site of direct inguinal hernias and is bordered by the inguinal ligament inferiorly, lateral margin of the rectus sheath medially, and inferior epigastric vessels laterally. The floor of this triangle is composed of transversalis fascia. (*Peiper C et al., 2004*)

The transversalis fascia covers the deep surface of the transverses abdominis muscle and, with its various extensions, forms a complete fascial envelope around the abdominal cavity

This fascial layer is regionally named for the muscles that it covers-for example, the iliopsoas fascia, obturator fascia, and inferior fascia of the respiratory diaphragm. The transversalis fascia binds together the muscle and aponeurotic fascicles into a

continuous layer and reinforces weak areas where the aponeurotic fibers are sparse. This layer is responsible for the structural integrity of the abdominal wall and, by definition, a hernia results from a defect in the transversalis fascia.

The rectus abdominis muscles are paired muscles that appear as long, flat triangular ribbons wider at their origin on the anterior surfaces of the fifth, sixth, and seventh costal cartilages and the xiphoid process than at their insertion on the pubic crest and pubic symphysis. Each muscle is composed of long parallel fascicles interrupted by three to five tendinous inscriptions, which attach the rectus abdominis muscle to the anterior rectus sheath. There is no similar attachment to the posterior rectus sheath. These muscles lie adjacent to each other, separated only by the linea alba. In addition to supporting the abdominal wall and protecting its contents, contraction of these powerful muscles flexes the vertebral column. (*Glassow F et al., 1973*)

The rectus abdominis muscles are contained within the rectus sheath, which is derived from the aponeuroses of the three flat abdominal muscles. Superior to the semicircular line, this fascial sheath completely envelops the rectus abdominis muscle, with the external oblique and anterior lamella of the internal oblique aponeuroses passing anterior to the rectus abdominis and

aponeuroses from the posterior lamella of the internal oblique muscle, transversus abdominis muscle, and transversalis fascia passing posterior to the rectus muscle. Below the semicircular line, all these fascial layers pass anterior to the rectus abdominis muscle, except the transversalis fascia. In this location, the posterior aspect of the rectus abdominis muscle is covered only by transversalis fascia, preperitoneal areolar tissue, and peritoneum. (*Keith L. Moore et al., 2014*)

The rectus abdominis muscles are held closely in apposition near the anterior midline by the linea alba. The linea alba consists of a band of dense, crisscrossed fibers of the aponeuroses of the broad abdominal muscles that extends from the xiphoid to the pubic symphysis. It is much wider above the umbilicus than below, thus facilitating the placement of surgical incisions in the midline without entering the right or left rectus sheath. (*Fitzgerald, J. E. F et al., 2009*)

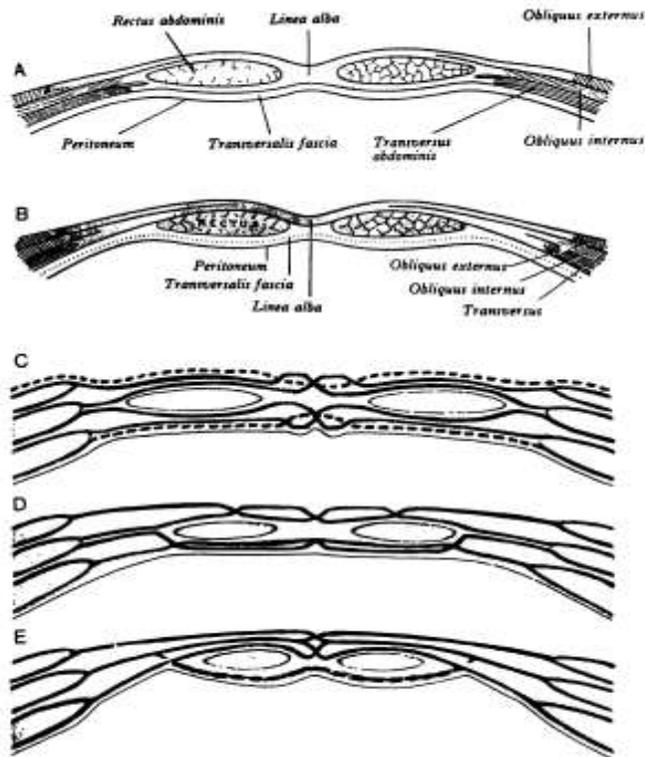


Figure (1): Transverse sections through the anterior abdominal wall, traditional view: (A) Immediately above the umbilicus. (B) Below the arcuate line. (C–E) Schematic transverse sections through the ventral abdominal wall showing bilaminar aponeuroses, external oblique, internal oblique, transversus abdominis, and sites of linear decussation that compacted from linea alba. (By permission of PL Williams, R Warwick, and M Dyson, et al. (eds.), *Gray's Anatomy*, 37th ed. Edinburgh: Churchill Livingstone, 1989.)

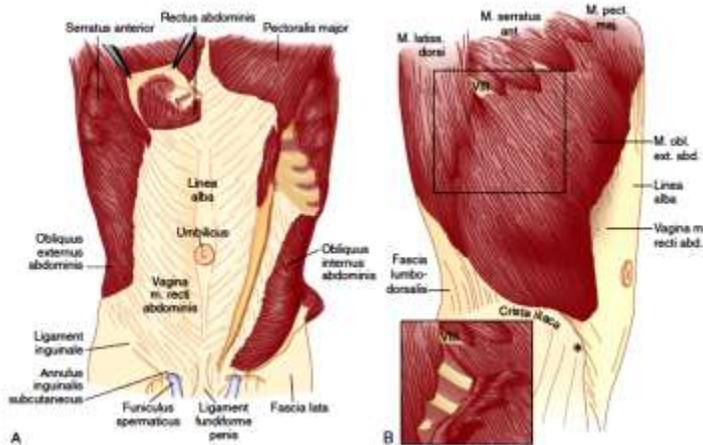


Figure (2): A, External oblique, internal oblique, and rectus abdominis muscles and anterior rectus sheath. B, Lateral view of the external oblique muscle and its aponeurosis as it enters the anterior rectus sheath. *Inset*, Origin of the external oblique muscle fibers from the lower ribs and their costal cartilages. (From McVay C: *Anson and McVay’s surgical anatomy*, ed 6, Philadelphia, 1984, WB Saunders, pp 477–478).

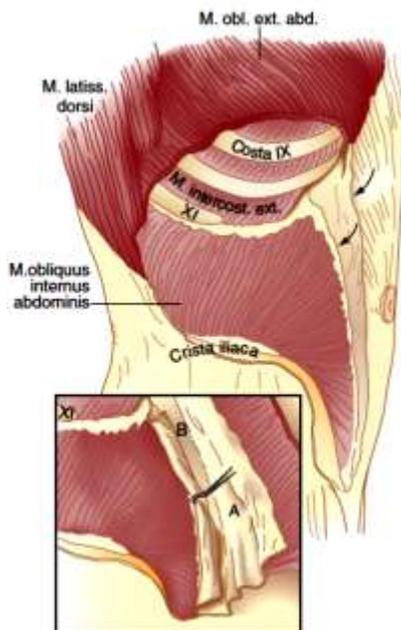


Figure (3): Lateral view of the internal oblique muscle. The external oblique muscle has been removed to show the underlying internal oblique muscle originating from the lower ribs and costal cartilages. (From McVay C: *Anson and McVay’s surgical anatomy*, ed 6, Philadelphia, 1984, WB Saunders, p 479)

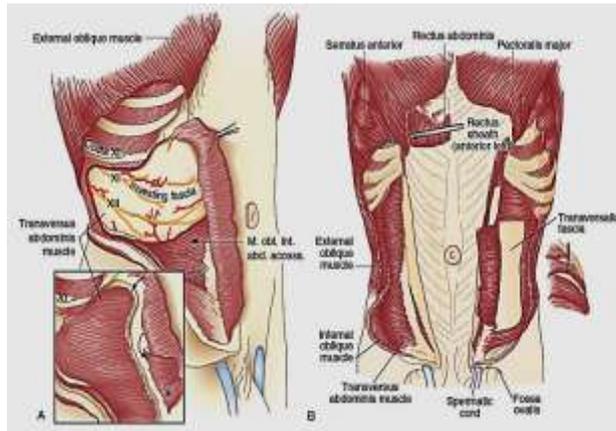


Figure (4): A, Anterolateral view of the investing fascia of the transversus abdominis muscle and the muscle itself with the fascia removed. The external and internal oblique muscles have been removed. Also note the appearance of the intercostal nerves lying between the fascia of the transversus abdominis muscle and internal oblique muscle. B, Anterior view of the transversus abdominis muscle (*left*) and the transversalis fascia (*right*). Note that the transversalis fascia is shown by reflecting the overlying transversus abdominis muscle medially. (*From McVay C: Anson and McVay's surgical anatomy, ed 6, Philadelphia, 1984, WB Saunders, pp 480–481.*)

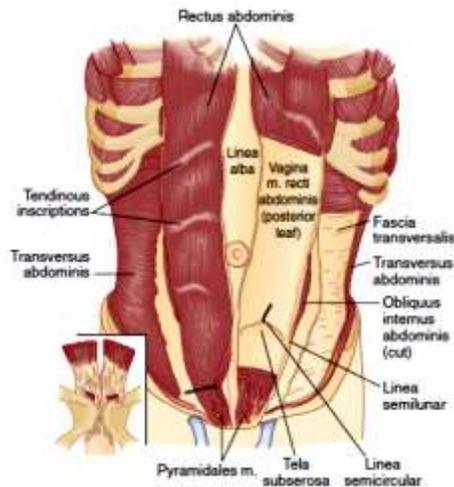


Figure (5): Rectus abdominis muscle and contents of the rectus sheath. Note the semicircular line below which the posterior rectus sheath is absent; the rectus abdominis muscle overlies the transversalis fascia, pre-peritoneal areolar tissue, and peritoneum. (*From McVay C: Anson and McVay's surgical anatomy, ed 6, Philadelphia, 1984, WB Saunders, p 482.*)

The inguinal canal

The inguinal canal is a slit-like space in between the muscles of the anterior abdominal wall, above the medial half of the inguinal ligament. It contains the spermatic cord and the ilioinguinal nerve in the male and the round ligament of the uterus and the ilioinguinal nerve in the female. It is about 6cm long and extends from the deep inguinal ring to the superficial inguinal ring (external ring). The deep inguinal ring is a defect in the transversalis fascia about 1cm above the midpoint of the inguinal ligament. The superficial inguinal ring, which is above and lateral to the pubic tubercle, is a defect in the external oblique aponeurosis. (*Flament JB et al., 2001*)

Deep inguinal ring:

It is an opening in the fascia transversalis 1 cm above the mid inguinal point between pubic symphysis and anterior superior iliac spine. It is of an oval shape, the long axis being vertical. It is larger in male than in female. At its margins the fascia transversalis is condensed. Medially it is related to the inferior epigastric vessels.

Superficial inguinal ring:

It is an opening in the aponeurosis of external oblique muscle. It is situated just above and lateral to the Pubic crest. The aperture is triangular with its long axis oblique

corresponding to the course of the fibers of the aponeurosis. This is smaller in the females. Its base is formed by the pubic crest and its sides by the margins of the opening of the aponeurosis, which are called the crura of the ring.

Walls of the inguinal canal:

The anterior wall (i.e. structures in front of the spermatic cord) is formed by the external oblique aponeurosis reinforced laterally by fibres of the internal oblique. The posterior wall (structures behind the spermatic cord) throughout is formed by the transversalis fascia and is reinforced medially by the conjoint tendon. (*Skandalakis JE et al., 1989*)

Roof and floor of the inguinal canal:

The roof of the canal (structures above the cord) is formed by the arched fibers of the transversus and the internal oblique. The floor, on which the spermatic cord lies, is formed by the inguinal ligament. The lacunar ligament (pectineal part of the inguinal ligament or Gimbernat's ligament), which is the continuation of the attachment of the inguinal ligament to the pubic ramus, is an additional structure on the floor in the medial part of the canal. (*Skandalakis JE et al., 2000*)

The inferior epigastric vessels are an important landmark. They arise from the external iliac vessels and course superiorly to lie deep to rectus abdominis. Just after their origin